Financial Innovation and Money Demand in Sub-Saharan Africa

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Abstract

Financial innovations are considered important factors in the development of the financial sector and economic growth. Following the 2007/2008 financial crisis, their effects, both positive and negative, have become an issue of considerable debate, especially in industrialised countries. While a number of empirical studies on the effects of financial innovation have been undertaken for industrialised countries, few developing country studies exist. This is surprising, given the remarkable growth of financial innovation in some developing economies. In particular, mobile money (M-PESA), a technology first developed in Kenya that enables individuals to transfer, deposit and save money using cell phone technology without necessarily having a bank account, has quickly spread to several developing countries and is expected to continue to expand. This thesis contributes to the limited literature by undertaking a panel study of the effect of financial innovation on money demand in Sub-Saharan Africa as well as a case study of the home of mobile money, Kenya. A third study considers how mobile money has influenced household consumption behaviour using data from Uganda.

In chapter two, the effect of financial innovation on money demand in Sub-Saharan Africa is investigated in 34 countries for the period 1980 to 2013 using dynamic panel data estimation techniques. Money demand is found to be relatively stable in the region with financial innovation significant with a negative sign. While the coefficients on the other relevant variables are significant with expected signs, the size of the coefficients change with the inclusion of financial innovation. This suggests that exclusion of financial innovation may have led to biased or misleading estimates of the money demand equation in previous studies, and that financial innovation plays a significant role in explaining money demand in Sub-Saharan Africa.

Given the potential importance of this form of financial innovation, a case study of the impact of mobile money on money demand in Kenya is undertaken in chapter three. Using time series analysis on a quarterly basis for the period 2000–2014, the results suggest a positive relationship between mobile money and money demand. The Kenyan demand for money is found to be stable when mobile money is taken into consideration. These results are robust even with the use of alternative measures of mobile money and imply that this particular financial innovation has

important implications for the effectiveness of monetary policy in Kenya and possibly in other similar countries.

While mobile money has been found to have important macroeconomic effects, there is little research on how it affects the real economy. Chapter four investigates the way this type of financial innovation can alter household behaviour, particularly household consumption patterns. Since data was not available for Kenya, Uganda was used as a case study. It is one of the countries that has been successful in mobile money usage since its introduction in 2009. The Financial Inclusion Tracker Surveys (FITS) household level survey conducted in 2012 also provides valuable data. Using ordinary least squares and seemingly unrelated regression estimation techniques, the results suggest that mobile money users spend less on food, a necessity, and more on luxury goods, than non-users. In addition, mobile money users are more likely to receive more remittances, and as a result, they are able to spend more efficiently on particular commodities than non-users. This suggests that mobile money could potentially improve individuals' livelihoods.

Finally, chapter five concludes with a discussion of the summary of the findings from the thesis, the policy implications, and the suggestions for future research.

Dedication

To my parents, Martin and Margaret Kasekende.

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List of Abbreviations

AERC	African Economic Research Consortium
AIDS	Almost Ideal Demand System
KEPSS	Kenya Electronic Payments and Settlement System
KNBS	Kenya National Bureau of Statistics
AIC	Akaike Information Criteria
ADF	Augmented Dickey Fuller
ATM	Automated Teller Machine
ARDL	Autoregressive Distributed Lag
BIC	Bayesian Information Criterion
CBK	Central Bank of Kenya
CIA	Central Intelligence Agency
CPI	Consumer Price Index
CUSUM	Cumulative Sum of Recursive Residuals
CUSUMSQ	Cumulative Sum of Squares Recursive Residuals
DOLS	Dynamic Ordinary Least Squares
EAC	East African Community
DFE	Dynamic Fixed Effects
ECOWAS	Economic Community of West African States
EFT	Electronic Funds Transfer
E-money	Electronic Money
ERSA	Economic Research Southern Africa
ESSA	Economic Society of South Africa
FGLS	Feasible Generalised Least Squares
FITS	Financial Inclusion Tracker Surveys
FMOLS	Fully Modified Ordinary Least Squares
GMM	Generalized Method of Moments
GDP	Gross Domestic Product
IFS	International Financial Statistics
IMF	International Monetary Fund
KES	Kenyan Shilling
MG	Mean group
M-PESA	Mobile Money
MTN	Mobile Telecommunications Network
NDA	Net Domestic Assets
NIR	Net International Reserves
NER	Nominal Exchange Rate

NBFIs	Non-Bank Financial Institutions
OLS	Ordinary Least Squares
QAIDS	Quadratic Almost Ideal Demand System
RER	Real Exchange Rate
SADC	South African Development Community
SURE	Seemingly Unrelated regression
SSA	Sub-Saharan Africa
PMG	Pooled Mean group
TBILL	Treasury Bill
USD	United States Dollar

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Chapter 1

Introduction

1.1 Introduction

Financial innovation is an important factor in the development of the financial sector and economic growth, and while it may seem easy to comprehend because it is not a new phenomenon, it is much more complex. It begun as early as the 1960s and quickly spread within the United States and other developed countries (Levich et al., 1988), and more recently, to developing economies as well. It is something new that satisfies participants' demands through reduced costs, reduced risks and improved products (Frame and White, 2004; 2014), and can be grouped into either processes, or products and services (Tufano, 2003; Frame and White; 2014) [1], for example, the liberalization of financial markets, securitization, and new products such as ATMs and debit cards, among others. While these financial innovations pose some common features, they may differ by country (Levich et al., 1988), and could potentially have different effects on the financial sector and the economy.

In the past, several researchers had agreed that financial innovation enhances the financial sector and has the potential to lead to benefits for the economy. However, following the 2007/2008 financial crisis where financial innovation was partly blamed for the crisis, there has been considerable debate on the positive and negative effects of these innovations on the economy. Beck et al. (2012) refer to this as the bright and dark sides of financial innovation. Extensive arguments have been made to link financial innovation to market crashes, for example, the 1987 market crash (Tufano, 2003), and the 2007/2008 financial crisis due to problems with credit default swaps and securitisations (Allen, 2012). Tufano (2003) and Beck et al. (2012) share similar sentiments that these innovations have the ability to lead to market volatility and bank fragility. These arguments were further intensified by economists such as Paul Volcker, the former Federal Reserve Bank chairman, who claimed that financial innovation does not seem to

[1] Financial innovation also includes both technological processes and financial regulation or deregulation (Arrau and De Gregorio, 1991).

have any benefits on the economy with the exception of the ATM that has improved society in the last 25 years (The Wall Street Journal 8th and 14th December, 2009). On the contrary, other studies such as Leaven et al. (2015), Beck et al. (2012), and (Chou 2007) have found evidence of a positive relationship between financial innovation and economic growth with Lerner and Tufano (2011) arguing that households are likely to make new investment and consumption choices as a result of financial innovation.

While a number of studies on the effects of financial innovation have been undertaken in industrialised countries because they account for most of the developments in these innovations, few developing country studies exist. This is surprising given the considerable growth in financial innovations in some developing economies in recent years. In particular, SSA has seen enormous developments in financial innovations following the financial reforms and liberalization of exchange rates and interest rates in some countries in the 1980s and 1990s, the introduction of ATMs and debit cards in the 1990s, and most recently, mobile money (M-PESA)[2]. Mobile money, a technology first developed in Kenya in 2007 by the leading telecommunication company Safaricom, enables individuals to transfer, deposit and save money using cell phone technology without necessarily having a bank account (Jack and Suri, 2011). Although mobile money users are not required to have a bank account, they have to register for a mobile money account with a telecommunication company to send money using mobile money technology, a procedure often easier than opening up a bank account[3]. Mobile money has been successful in Kenya and has spread quickly to a number of developing countries with over 255 mobile money networks in 89 countries in 2014 according to the GSMA (2014). In addition, the East African region has had the most success in mobile money usage since its introduction in Kenya with over 80 percent of all mobile money transactions processed in East Africa, according to Davidson Pénicaud's (2012) worldwide survey in 2011. Moreover, Kenya, Uganda and Tanzania were found to have more mobile money accounts than bank accounts (Pénicaud, 2013).

Mobile money has continued to evolve in a number of ways, from a payment system used to send and receive remittances, to being able to get loans without necessarily having a bank account. For example, individuals can now get loans based on credit history from M-PESA to a

[2] M-PESA is a Swahili word that means mobile money, where M stands for mobile and PESA for money.
[3] Most telecommunication companies require one to have an ID to open up a mobile money account. This is usually an easier process than the requirements for opening up a bank account.

paperless bank account, M-Shwari, using their mobile phones (Safaricom, 2014). The most recent modification to mobile money, where individuals are likely to benefit, is the partnership between Kenya's Safaricom and three telecommunication companies in East Africa, including Tanzania's Vodacom, Rwanda's MTN, and now most recently, Uganda's MTN, which will introduce cross border transactions with uniform prices across countries that could potentially boost trade (Kariuki and Gicobi, 2015; Ochieng, 2015). Due to the large number of informal cross border trade in the region, mobile money users are highly likely to benefit substantially from this new venture. This success in mobile money usage in low income countries could have been due to improvements in regulations, reforms and growth in telecommunications. The SSA region has seen a huge rise in cell phone penetration with 60 percent mobile phone coverage according to Aker and Mbiti (2010). This has been further emphasised in a most recent 2016 afrobarometer report that indicates that out of the 35 African countries considered, 93 percent had access to a cell phone in 2014/2015 (see Mitullah et al., 2016). The mobile money technology has the potential to improve individuals' access to financial services, especially the unbanked who would otherwise not have had access to financial services.

Financial services in most developing countries are either non-existent or underdeveloped and financial innovations enhance the financial system. While the main function of the financial system, according to Merton (1990), is to enable the allocation and deployment of economic resources, market imperfections could limit individuals from efficiently benefiting from the financial system (Tufano, 2003). This could potentially lead to the development of financial innovation to try and close this gap in the system, especially among low income countries. These countries are likely to become innovative in a variety of ways to protect themselves against risk, because of limited or missing financial markets (Morduch, 1995). The gaps in the financial system could be due to the uncertainty in the future, hence new products, services and instruments play a role in satisfying individuals' demands by reducing the costs involved in the risk (Frame and White, 2004).

Given the recent growth in financial innovation, a major factor of concern is its potential impact on money demand, which could have implications for monetary policy, and its effect on the real economy. This thesis contributes to the limited literature on financial innovation on both a macroeconomic level and a microeconomic level in three ways. First, it offers a regional level

analysis of the effect of financial innovation on money demand in SSA. Second, it provides a case study from the home of mobile money, Kenya. Lastly, it investigates the effect of mobile money on household consumption behaviour in Uganda.

In chapter two, the first objective of the thesis is addressed by investigating the effect of financial innovation on money demand in Sub-Saharan Africa. A regional level analysis was considered given the recent growth in financial innovations and the limited number of studies undertaken on its likely impact on money demand in SSA. There has been an ongoing debate on the stability of the money demand with suggestions that the traditional money demand relationship has broken down in a number of countries partly due to its misspecification. Money demand instability was found to be one of the reasons for failure in monetary aggregate targeting. As a result, a number of countries such as New Zealand, United Kingdom, Canada and Sweden moved to inflation targeting (Mishkin, 1999). While developing countries including South Africa, Kenya and Uganda also moved to inflation targeting, many countries are still targeting monetary aggregates. With unstable demand for money, monetary targets are likely to continue being missed, making it difficult for Central Banks to conduct monetary policy efficiently. Tahir (1995) argues that money demand instability can be explained by a fundamental change in the economy.

Financial innovation is a potential fundamental change that could lead to the breakdown of the relationship between money demand and its determinants. Prior to the mid-1970s when most empirical results depicted a stable money demand, a limited number of variables such as the interest rate and output were sufficient to achieve a stable money demand (Goldfeld and Sichel, 1990). However, researchers are now accounting for financial innovation in the money demand specification (see Arrau and De Gregorio, 1993; Augustina, et al., 2010; Alvarez and Lippi, 2009). Arrau et al. (1995) agree with this argument as they consider financial innovation to be a permanent change to the money demand that is not caused by opportunity cost (i.e. interest rates) and scale variables (such as GDP).

While studies based on industrialised countries, such as Lippi and Secchi (2009), Attanasio et al. (2002), Arrau and De Gregorio (1993), and Alvarez and Lippi (2009) have found financial innovation to have had an impact on money demand, only a few country case studies have analysed this relationship in developing countries (see Kararach, 2002; Ndirangu and Nyamongo, 2015; Augustina et al., 2010), and with little emphasis on a regional level analysis.

Financial innovation is often associated with a decline in money demand because cash that would have been carried in wallets can now be replaced by these innovations, and as a result it could lead to a decline in demand for cash. Similarly, as individuals move away from more liquid assets (cash or M1) to less liquid assets (broad money or M2, M3), they are more likely to demand less money.

The relationship between financial innovation and money demand is analysed on a regional level in this chapter using dynamic panel data estimation techniques, including the pooled mean group (PMG), mean group (MG) and the dynamic fixed effects (DFE) with a broad measure for financial innovation (M2/M1) in addition to other proxies of financial innovation for 34 countries between 1980 and 2013. Money demand is found to be relatively stable in the region with financial innovation significant, with a negative sign. While the coefficients on the other relevant variables are significant, with expected signs, the size of the coefficients change with inclusion of financial innovation. This suggests that exclusion of financial innovation may have led to biased or misleading estimates of the money demand equation in previous studies, and that financial innovation plays a significant role in explaining money demand in Sub-Saharan Africa. This implies that as individuals move away from more liquid assets to less liquid assets, they tend to demand less money. Given the importance of these findings, it is important to investigate the effect of a particular type of financial innovation, such as mobile money, using country specific case studies because of its uniqueness. This could potentially lead to a different effect of money demand compared to the broader measures of financial innovation.

This research is undertaken in chapter three by investigating the relationship between mobile money and money demand in Kenya. The implications for mobile money are not well understood, especially at the macroeconomic level, as it is a new technology that only began in 2007 with limited empirical research in the area. Kenya is specifically interesting given the fact that it was the first country to introduce mobile money, and it has the largest number of mobile money users in the world. In addition to having more mobile money users than bank accounts (Pénicaud, 2013), Kenyans also send and receive a high number of remittances. Approximately, 61 and 67 percent of the 2011 adult population in Kenya were found to be using their mobile phones to send and receive remittances, respectively (Allen et al., 2014). Therefore, failure to account for mobile money could complicate monetary policy effectiveness, since the Central

Bank of Kenya (CBK) conducts monetary policy based on monetary aggregate targeting. In other words, it uses the Net Domestic Assets and Net International reserves as the operational parameters and monitors M3 and private sector credit (see CBK Monetary Policy Statement, 2014b). However, due to the failure of the monetary aggregate targeting, in 2011, Kenya started the process to try and transition to a more forward looking monetary policy so that it can gradually move towards inflation targeting (IMF, 2015). So, a vital question that is worth investigating is whether the demand for money remained stable following the recent developments in financial innovation in Kenya.

The few studies that have attempted to capture the effect of financial innovation on the Kenyan money demand use other proxies for financial innovation. For example, Sichei and Kamau (2012) use the number of ATMs, while Ndirangu and Nyamongo (2015) use currency outside banks/time deposit ratio. No study to the best of my knowledge has carried out an in-depth analysis on the potential impact of mobile money on the demand for money. While most literature finds a negative relationship between financial innovation and money demand, mobile money is likely to lead to either a positive or negative relationship. On the one hand, mobile money is initially expected to lead to a positive effect on money demand as individuals who would otherwise not have had access to financial services can now do so because of this innovation. These individuals include those that used to keep their money under the mattress, or those who were involved in barter trade prior to the introduction of mobile money. On the other hand, as mobile money continues to evolve, transactions costs are likely to decline, making it much easier for both the banked and unbanked individuals to carry out financial transactions and as a result, individuals may demand less money as they start investing in other assets other than cash. Thus, the sign of the effect of mobile money on money demand is an empirical question as it can either be positive or negative depending on which effect is greater.

Chapter three tries to fill this gap in the literature by investigating the relationship between mobile money and money demand using the ARDL approach to cointegration on a quarterly basis for the period 2000 to 2014. The results depict a stable money demand when mobile money is taken into consideration, and a positive relationship between mobile money and money demand. These findings are robust even with the use of alternative measures of mobile money. This suggests that individuals may initially continue to demand electronic money and cash

through the use of cell phone technology and not necessarily move away from more liquid assets to less liquid assets as often seen with several types of financial innovation. Hence, as mobile money usage increases, demand for money increases as well.

While mobile money has been found to have important macroeconomic effects, there is little research on how it affects the real economy. In chapter four, a microeconomic approach is undertaken to investigate how this type of financial innovation could potentially alter household behaviour. Since data was not readily available for Kenya, the most successful country in mobile money usage, Uganda, was considered. It is one of the most successful countries in mobile money usage since its introduction in the country in 2009 by Uganda's leading telecom company MTN. It also has more mobile money users than registered bank accounts, as in the case of Kenya (Pénicaud, 2013). It is thus likely to have an impact on household consumer behaviour. Mobile money has a potential to have an effect on consumer behaviour through the remittances received and this could be achieved in two ways. First, through consumption smoothing as households can insure themselves against temporary shocks (Deaton, 1997), and second, through the rise in income that could alter household consumption patterns.

As income increases, households are better able to spend on particular goods such as luxuries and less on necessities such as food. Thus, mobile money has a potential to lower transaction costs and this could enable households to allocate their resources efficiently and change their consumption patterns (Ramada-Sarasola, 2012). This change in demand for various goods is important as it could potentially have implications for economic development. However, few studies on mobile money have concentrated on its effect on total consumption. For example, Jack and Suri (2014) find that consumption of mobile money user households in Kenya are unaffected by shocks, whereas non-users see a decline in consumption. While this study compares the effects of mobile money on total consumption and food consumption, it fails to investigate the consumption patterns of a number of household items. A similar study for the case of rural Uganda by Munyegera and Matsumoto (2014) finds that mobile money has a positive effect on consumption in rural Ugandan households, largely on account of the remittances received. While they also compare their results to the total food consumption and total non-food consumption, they do not focus on household consumption patterns of various household goods per se. Rather, they concentrate on the effect of mobile money on welfare using consumption per capita as a

measure for welfare. They also only concentrated on rural Ugandan households. This is a limitation of their study considering the popularity of mobile money usage in urban areas. To the best of my knowledge, no studies representative of the whole country have been conducted on the effect of mobile money usage on household consumption patterns.

In chapter four, an investigation of the effect of mobile money on household consumption patterns in Uganda is conducted using the 2012 Financial Inclusion Tracker Surveys (FITS) household level dataset that is representative of the country. The Working-Leser model, a type of Engel curve that relates budget shares linearly to the log of expenditure, is employed. This model seems appropriate for cross section studies given the fact that it complies with the adding up restriction of the demand analysis (Deaton and Muellbauer, 1980a). The Ordinary Least Squares Estimation Technique (OLS) was considered in the analysis and the Seemingly Unrelated Regression (SURE) was used for robustness checks. The SURE was employed as the OLS method may produce inefficient results due to correlation of the error terms which would make the SURE results more efficient. Mobile money users were found to spend less on food, a necessity, and more on luxury goods than non-users. These findings suggest that as a result of the remittances received, mobile money users are likely to spend more efficiently on particular commodities than non-users. This suggests that mobile money not only improves access to financial services, but could potentially improve individuals' livelihoods.

In conclusion, this research tries to fill in the gap in the relevant literature by concentrating on both the broad measures and specific measures of financial innovation in Sub-Saharan Africa where few studies have been conducted. The findings indicate that financial innovation is important in explaining money demand in SSA. In addition, given new innovations such as mobile money in the region, these results have important monetary policy implications. While some Sub-Saharan African countries such as Ghana, Uganda and South Africa have moved towards inflation targeting, several countries maintain monetary aggregate targeting and could be affected by a money demand function that is unstable. Given the fact that a stable and well specified demand function is an important input in monetary policy, not accounting for financial innovation implies that money demand models would not be well specified leading to biased estimates. This is also true for the results on the effect of mobile money on money demand depicted in Chapter three.

The positive relationship between money demand and mobile money in addition to money demand stability in chapter 3, have important implications for the effectiveness of monetary policy in Kenya and possibly in other countries that have seen developments in mobile money in recent years. That is, failure to account for mobile money in the money demand specification can hinder the proper monitoring of prices by the monetary authorities. In addition to the macroeconomic contribution, this thesis also contributes to the microeconomic literature of financial innovation by investigating the relationship between mobile money and household consumption patterns in Uganda. The results suggest that mobile money not only enables individuals to receive more remittances, but also enables them to spend more efficiently on particular commodities than non-users, which could potentially lead to economic development.

1.2 Organization of Thesis

The rest of the thesis is organised as follows. The second chapter investigates the development of financial innovations and its impact on money demand in Sub-Saharan Africa using dynamic panel data estimation techniques for 34 countries between 1980 and 2013. This is followed by chapter three that estimates the Kenyan money demand including the country specific innovation, mobile money using the ARDL approach to cointegration over the period 2000Q1 to 2014Q2. The fourth chapter analyses the impact of mobile money on household consumer behaviour using the Ordinary Least Squares and the Seemingly Unrelated Regressions for Ugandan households based on the 2012 Financial Inclusion Tracker Surveys (FITS) household level data. Finally, the fifth chapter concludes with a discussion of the summary of the findings from the thesis, the policy implications, and limitations and suggestions for future research.

Chapter 2

Financial Innovation and Money Demand: Evidence from Sub-Saharan Africa

2.1 Introduction

Understanding the relationship between money demand and its determinants has been an important research focus over the years, mainly because of its importance for monetary policy. In particular, countries that conducted monetary policy through monetary aggregate targeting needed money demand to be predictable and stable. Recently, the stability of money demand has become an issue of debate, with suggestions that the traditional money demand relationships have changed in a number of countries. The breakdown in the relationship between monetary aggregates and variables such as income and inflation has been argued to have been an important reason for the failure in the monetary aggregate targeting in a number of countries, such as New Zealand, United Kingdom, Canada, and Sweden among others, leading them to move to inflation targeting (Mishkin, 1999). As well as instability, traditional money demand functions have also exhibited highly autocorrelated errors, implausible parameter estimates and persistent over prediction (Arrau et al., 1995). A potential explanation for this instability and misspecification of the money demand function is the rapid growth in financial innovation, which has been apparent in developed economies and has been an increasing characteristic of developing economies (Lieberman, 1977; Arrau and De Gregorio, 1991).

While studies based on industrialised countries, such as Lippi and Secchi (2009), Attanasio et al. (2002), Arrau and De Gregorio (1993) and Alvarez and Lippi (2009) have found financial innovation to have had an impact on money demand, few have analysed this relationship in developing countries. Kararach (2002), Ndirangu and Nyamongo (2015), and Augustina et al. (2010) provide useful case studies. This is despite the fact that Sub-Saharan Africa has seen considerable financial innovation, particularly during the last decade. Following the financial reforms and liberalization of exchange rates, and interest rates in the 1980s and 1990s, recent innovations have included the introduction of ATMs, debit cards and, more recently, mobile money, which started in Kenya in 2007 and quickly spread to other countries. This growth in

financial innovation could have important implications for monetary policy in the region, as most countries in Africa still use monetary aggregate targeting, except for a few countries such as South Africa, Ghana and Uganda which moved to inflation targeting.

In this chapter, the effect of financial innovation on money demand in Sub-Saharan Africa is considered using a panel of 34 countries for the period 1980 to 2013. The panel data setting addresses the issue of omitted variable bias by including an important variable, financial innovation. Few studies have focused on Sub-Saharan African countries, and those that have are generally country case studies. This chapter specifies a money demand equation that takes account of financial innovation and estimates it using dynamic panel data estimation techniques. In doing so, it evaluates the likely impact of the innovations. The next section provides a review of the literature, followed by the data, model specification and estimation in section 2.3. Section 2.4 then presents and discusses the results and some conclusions are considered in section 2.5.

2.2 Literature Review

A range of theories exist that link the quantity of money demanded to the real sector of the economy (Sriram, 2000). Classical economists argued that money is a medium of exchange and developed the transaction demand for money, which depicts the relationship between the quantity of money in circulation and the volumes of transactions and price. This led to the quantity theory of money, which sees income as the primary determinant of money (Serletis 2007). Keynes and the Keynesians then developed the quantity theory of money to include interest rates, arguing that individuals hold money for three reasons: the transaction/business motive, the precautionary motive, and the speculative motive. The transaction demand and precautionary demand reflect the role of money as the medium of exchange, with income playing a major role in determining money demand, while speculative demand reflects the role of money as a store of value, with individuals deciding between holdings of money or bonds. This makes interest rates, which are negatively related to money demand, important in the money demand specification (Serletis, 2007; Sriram, 1999). A third set of theories, commonly referred to as post-Keynesian, is often grouped based on whether money is used as a medium of exchange or a store of value (Sriram, 1999). Theories that are grouped under money as medium of exchange

are referred to as transactions theories. Examples of these include the Baumol-Tobin model, the shopping time model and the cash in advance models. Portfolio theories assume that money serves as a store of value and include the overlapping generation models and the Tobin's theory of liquidity preference (Serletis, 2007).

In empirical work, money demand specifications have generally included income and interest rates as the main determinants of money demand. Recently, however, the potential role of financial innovation in reducing transaction costs is being recognised. There are, however, some differences in definition. For instance, Melnik and Yashiv (1994, p.2) define financial innovation as the "introduction of new liquid assets that partially replace traditional money in agent's portfolios, technological progress in banking services that reduces the costs of transactions and changes in the regulatory environment that facilitate transactions". Frame and White (2004), on the other hand, considers financial innovation as something new that satisfies participant's demands through reduced costs, reduced risks and improved products. Other definitions have shifted the focus away from the cost reduction argument. For instance, Arrau et al. (1995) consider financial innovation as a permanent change to the money demand that is not caused by opportunity cost (i.e. interest rates) and scale variables (such as GDP), and Arrau and De Gregorio (1991) define it to include both technological processes and financial regulation or deregulation.

Different forms of financial innovations can have different effects on the money demand. For example, new products such as ATMS/ Debit cards or financial instruments could potentially improve efficiency and reduce transaction costs, as cash that would have been carried in wallets is replaced by these innovations, which could lead to a decline in demand for cash. Similarly, as individuals move away from more liquid assets (cash or M1) to less liquid assets (broad money or M2, M3), they are more likely to demand less money. In contrast, financial innovations could potentially lead to an increase in money demand if payments systems improve, but individuals demand more liquid assets. For example, in the case of M-PESA, individuals demand electronic money and cash through the use of cell phone technology, but do not initially move away from more liquid assets to less liquid assets.

Not accounting for these new financial innovations in money demand functions could be an important source of misspecification and could lead to unstable money demand (Arrau et al.,

1995; Goldfeld and Sichel, 1990). Empirical studies have redefined money or have included a proxy for reduced transaction costs as a result of financial innovation in the money demand specification, since exclusion of such variables was found to bias the money demand coefficient estimates and lead to autocorrelated errors, persistent over prediction and implausible parameter estimates (Arrau et al., 1995; Judd and Scadding, 1982; Lieberman, 1977).

As it is difficult to measure financial innovation directly, various proxies have been developed to measure financial innovation in both industrialised and developing countries. Examples include ATM concentration, bank concentration, M2/M1, M3/M1, growth rate in private sector credit, and dummy variables capturing periods of innovation. Studies that have attempted to use the number of ATMs include Fischer (2007) and Sichei and Kamau (2012) while Lippi and Secchi (2009), and Attanansio et al. (2002) use the number of ATM cards. Hafer and Kutan (2003) and Augustina et al. (2010) use a dummy variable to account for shifts in money demand, while Nagayasu (2011) considered bank concentration[4]. Michalopoulos et al. (2009) capture financial innovation using growth in private sector credit as a percent of GDP, while Arrau et al. (1995) use a time trend and a stochastic trend that follows a random walk to capture financial innovation.[5] Hye (2009) and Mannah-Blankson and Belyne (2004) use M2/M1 as a proxy of financial innovation. [6] The general finding points to a significant negative relationship between financial innovation and money demand, underlining the importance of accounting for financial innovation when analysing money demand[7].

Cross country studies on money demand have used panel data methods to analyse the long run relationship. These include Nautz and Rondolf (2010) who investigate the instability of money demand in the Euro Area, and Hamdi et al. (2014) who investigate the long run money demand function for the Gulf Cooperation Council countries.[8] The only cross country studies for Africa, Hamori (2008) and Salisu et al. (2013), that investigate the money demand equation do not consider financial innovation.

[4] "The dummy variable captures the shift in money demand (1 for the period of financial innovation and 0 otherwise) and it is used as a proxy for financial innovation as mentioned in the paragraph. Bank concentration is the commercial bank branches per 100,000 adults as defined in Table A2, Appendix A"

[5] Michalopoulos et al. (2009) investigate the relationship between financial innovation and endogenous growth.

[6] Mannah-Blankson and Belyne (2004) also use volume of cash cards in addition to M2/M1.

[7] Except a few studies, such as Hye (2009) for Pakistan, and Mannah-Blankson and Belyne(2004) for Ghana, that found a positive relationship between financial innovation and money demand, some studies such as Augustina et al. (2010) found no significant relationship.

[8] Hamdi et al. (2014) also use the DOLS and FMOLS in addition to the PMG to generate estimates.

2.3 Data, Model Specification and Estimation

In studying the Sub-Saharan African region, the choice of frequency of the data and the number of countries were all the result of data availability. A full unbalanced panel allowed a larger number of countries than a balanced panel. Annual data for 34 countries was collected, with the balanced panel comprised of 17 countries over a period of 34 years (1980–2013). A list of the SSA countries chosen for this study, with the respective time periods are shown in Appendix A, Table A1. All the variables used in this study were retrieved from the World Bank databank (2015). A detailed table of the variable description can be found in the Appendix A, Table A2.

The choice of the dependent variable, real M1, is based on the money demand theory and empirical literature. M1 is defined by the World Bank databank (2015) as the sum of currency outside banks and demand deposits other than those of the central government. M1 is the dominant component of money supply in developing countries (Rao and Kumar, 2009). There are some studies that have used M1 to capture money demand such as Rao and Kumar (2009) for Asian countries, and Mark and Sul (2003) for OECD countries. In Sub-Saharan Africa, Hamori and Hamori (2008) employed both M1 and M2, while Salisu et al. (2013) only considered M1.

In this analysis, real M1 is computed by dividing M1 by the consumer price index and then taking the log of the real money variable (LRM1). Financial innovation is then proxied using the commonly used ratio of M2 and M1 (M2/M1), which is readily available for most Sub-Saharan African countries[9]. The motivation for using this measure is that as financial innovations grow, individuals tend to move away from more liquid assets, which are reflected in M1, to less liquid assets, which are reflected in M2. The ATM concentration, bank concentration and private sector credit as a percent of GDP were also considered as alternative proxies for measuring financial innovation.[10] However, the M3/M1 proxy for financial innovation was not used in this analysis due to the limited data availability.

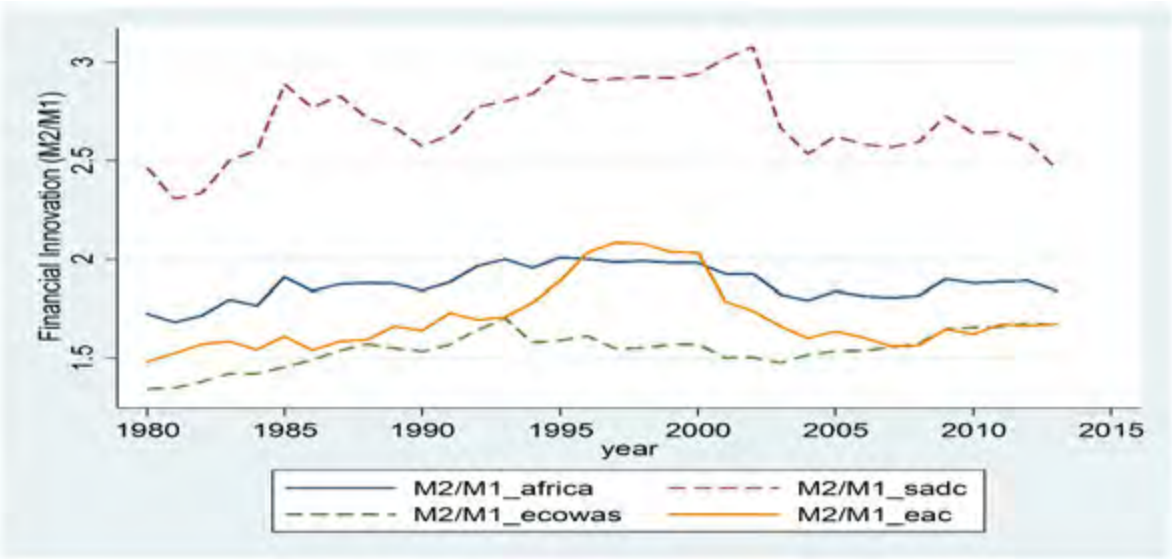
As Figure 1 shows, the increase in financial innovation in SSA, as reflected in M2/M1, started in the 1980s and 1990s during the period of major financial reforms in the region. There was also a

[9] Hye (2009) and Mannah-Blankson and Belyne (2004) use M2/M1. Lippi and Secchi (2009) and Fischer (2007) use ATMs.

[10] While Michalopoulos et al. (2009) capture financial innovation using growth in private sector credit as a percent of GDP, it is important to note that private sector credit to GDP is widely used as either a measure for financial intermediation or financial development (see Beck et al., 2000; King and Levine, 1993).

rise in innovations post 2008, specifically in the East African region, probably reflecting the growth in new technologies such as mobile money. The South African Development Community (SADC) has continuously dominated the region in terms of growth in financial innovation with countries such as Mauritius registering the highest financial innovation (M2/M1) of 7.3 compared to an average of 1.88 for Sub-Saharan Africa (see Summary Statistics in Table 1). While ATM and bank concentration figures have much less available data, they paint a similar picture, showing growth in financial innovation over time highly driven by SADC countries (see Figure 2), though other regions also show an increase in bank and ATM concentration in 2012 compared to 2004.

Figure 1: Financial Innovation in Sub-Saharan Africa

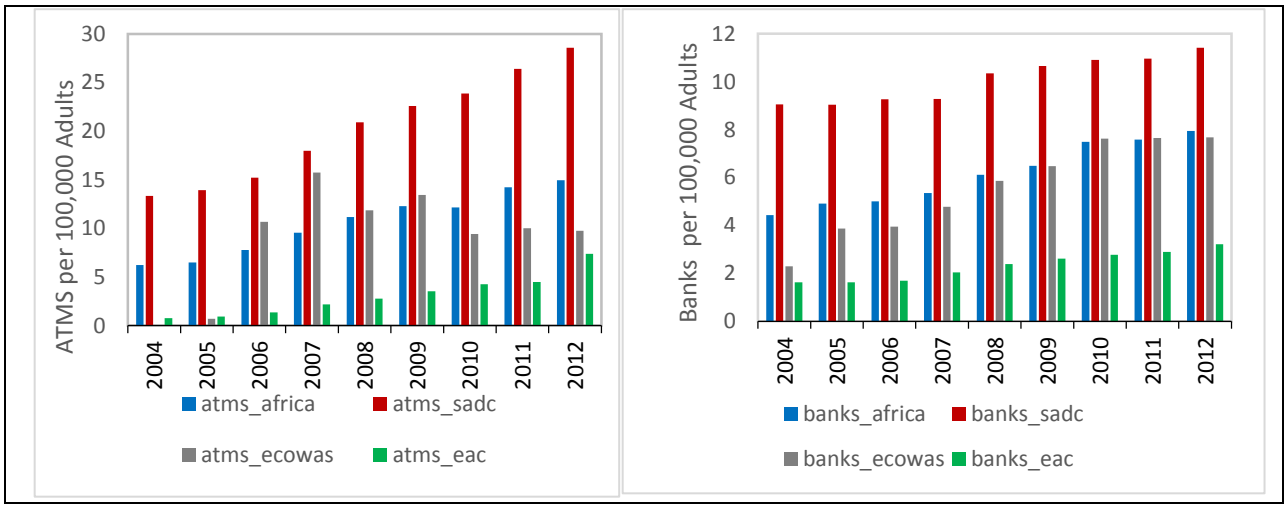


Source: Calculated using World Bank Databank (2015). ECOWAS stands for Economic Community of West African States, SADC is the South African Development Community, while EAC is the East African Community. All data was based on the 34 countries used in this study.

Income is represented by Real GDP, the log of GDP at constant 2005 US$(LRGDP) and the log of the nominal exchange rate (LNER) is measured as the average local currency per US$. The inflation rate is used to capture the opportunity cost of holding money rather than the interest rates partly because of the limited data on interest rates for Sub-Saharan African countries and also due to the fact that some of these countries do not have well developed financial markets. It follows Bahmani-Oskooee and Gelan (2009), and Suliman and Dafaalla (2011) who incorporate inflation. The inflation rate (INF) is based on consumer price index, but unlike the other

variables used in the study no logs were taken. Table 1 depicts the detailed summary statistics of all the variables used in the analysis for both the unbalanced and balanced panel.

Figure 2: Banks and ATM concentration in Sub-Saharan Africa



Source: Calculated using World Bank Databank (2015). ECOWAS stands for Economic Community of West African States, SADC is the South African Development Community, while EAC is the East African Community. All data was based on the 34 countries used in this study.

Table 1: Summary Statistics

	Summary Statistics- Unbalanced Panel				Summary Statistics -Balanced Panel			
	mean	sd	min	max	mean	sd	min	Max
Real M1	20.72	2.38	15.2	25.0	20.30	2.65	15.2	24.9
Inflation	10.58	15.21	-17.6	132.8	11.20	16.49	-7.8	132.8
Real GDP	22.12	1.51	18.5	26.5	22.50	1.58	19.4	26.5
Exchange Rate	4.23	2.81	-8.2	9.9	3.29	3.02	-8.2	7.3
Financial Innovation(M2/M1)	1.88	0.94	1.0	7.3	2.17	1.10	1.0	7.3
No. of Countries	34				17			
No. of Obs	993				578			

Source: World Bank Databank (2015).

Following Hamori (2008), an extended standard money demand specification is shown in equation (1), where money demand is a function of income, the opportunity cost of holding money and the exchange rate. This is then extended to include financial innovation and uses inflation as the opportunity cost of holding money.

$$LRM1_{it} = \beta_0 + \beta_1 INF_{it} + \beta_2 LRGDP_{it} + \beta_3 LNER_{it} + \beta_4 FINOV_{it} + \mu_{it} \quad (1)$$

$i = 1,2, \ldots, N, \;\; t = 1,2, \ldots, T$

Where LRM1 represents the log of real money M1, INF represents inflation rate, LRGDP represent income as measured by the log of real GDP. LNER represents the log of nominal exchange rate and FINOV financial innovation (M2/M1). The constant is captured by β_0 while μ denotes the error term.

Theory would predict a positive relation between income and money demand and this is generally found.[11] Studies do, however, differ in the size of the coefficients with some finding a coefficient of GDP less than 1 (see Hamori, 2008 and Salisu et al., 2013 for Sub-Saharan Africa; Kumar et al., 2013 for OECD countries; Fidrmuc, 2009 for Central and Eastern European countries; and Hamdi et al., 2014 for Gulf cooperation council countries) and others a coefficient either equal to 1 or higher than 1 (see Mark and Sul, 2003 for OECD countries; Hamori and Hamori, 2008, Nautz and Rondorf 2010, and Arnold and Roelands 2010 for EU countries).

Interest rates are often used to capture the effect of the opportunity cost of holding money on money demand and would be expected to have a negative sign. While most studies find this, the size of the coefficient varies (although it is mainly less than one)[12]. Various measures have been used such as the Treasury bill rate (see Hafer and Kutan, 2003; Sichei and Kamau, 2012; Kiptui, 2014; Hamdi et al., 2014), the long term government bond yield (see Bahmani-Oskooee and Bohl, 2000; Nautz and Rondorf, 2010; Arnold and Roelands, 2010), and inflation. Inflation is often used as a proxy for the opportunity cost of holding money in developing economies because of limited financial markets, lack of well-regulated interest rates, and shortage of data on interest rates (see Tahir, 1995; Sriram, 1999; Bahmani-Oskooee and Gelan, 2009)[13]. This is particularly true in African countries. Recent studies, such as Suliman and Dafaalla (2011) for Sudan, and Bahmani-Oskooee and Gelan (2009) for several African countries, and Salisu et al.

[11] The quantity theory of money predicts that income coefficient is approximately 1, while the Baumol-Tobin model predicts it to be 0.5 (Serletis, 2007).
[12] This is in line with the Bahmol-Tobin model which assumes the coefficient to be negative and equal to 0.5 (Serletis, 2007).
[13] It would have been interesting to see correlations between inflation and interest rates to further motivate the use of inflation as a proxy for the opportunity cost of holding money, unfortunately several countries used in this study lack data on interest rates.

(2013) for Sub-Saharan Africa, all used inflation as a proxy for the opportunity cost of holding money. [14]

The expected sign of the exchange rate coefficient is ambiguous, as it is dependent on whether wealth effects or substitution effects are greater. For example, if there is evidence of a wealth effect, the sign of the exchange rate is positive. This implies that a depreciation of the exchange rate leads to an increase in money demand. Put differently, depreciation in the exchange rate leads to an increase in foreign assets by domestic residents and thus a rise in wealth (Dobson and Ramlogan, 2001). This increase in the demand of goods from abroad due to the depreciated exchange rate could lead to higher inflation and a higher demand for money due to the increase in the number of transactions (Dreger et al, 2007). If the sign of the exchange rate is negative, however, then money demand is expected to decline due to the substitutability of domestic currency for foreign currency or bonds, since there are higher returns from holding foreign money (Sriram, 2000). In other words, the confidence in the domestic exchange rate is lowered due to the depreciation and as a result, money demand declines through a substitution effect with foreign money(Dreger et al, 2007).Studies such as Narayan et al. (2009) on South Asian countries found a positive relationship between the exchange rate and money demand, while other studies such as Kumar et al. (2013) and Dobnik (2013) for OECD countries, Dreger et al. (2007) for EU countries, and Salisu et al. (2013) for Sub-Saharan Africa found a negative one.

Given the importance of dynamics and the potential for heterogeneity in estimating a demand for money function for Sub-Saharan Africa, a number of panel data methods are used. These are namely, Dynamic Fixed Effects (DFE), Mean Group (MG) and the Pooled Mean Group (PMG) estimation techniques for comparison[15]. An ARDL specification allows for a dynamic structure;

[14] Salisu et al. (2013) use both interest rates and inflation.

[15] The Pooled Mean group (PMG) estimator by Pesaran et al. (1999) is often used to generate long run and short run estimates for data with large time series and cross sections where non stationarity may be an issue (Pesaran et al., 1999). Unlike other models like the FMOLS and DOLS, no stationarity test was formally proposed by Pesaran et al. (1999). However, the asymptotic properties of the estimator for both stationary and non-stationary regressors was derived (Roudet et al., 2007). In addition, Pesaran et al. (1999) do not exclusively test for cointegration, but they do make assumptions for the existence of cointegration. The PMG allows for the identical long run coefficients, while the short run coefficients and error variances are allowed to differ across groups. This defers from the Mean group (MG) estimator which is derived by estimating separate equations and calculating their coefficient means (Pesaran et al., 1999). When it comes to panel data with long time dimension, the PMG and MG estimators are often preferred to the traditional panel data methods such as GMM. This is because traditional panel data methods yield inconsistent estimates, while MG and PMG estimators yield consistent parameters with long time series and large cross sections. The PMG estimator may also be preferred to the MG with shorter time series since MG estimates tend to be biased with smaller time dimensions (see Asteriou and Hall, 2007; Pesaran et al., 1999). The main advantage of the PMG

the Dynamic Fixed effects estimators (DFE) allow the intercepts to vary while all coefficients are fixed; the Pooled Mean Group (PMG) estimator restricts all coefficients in the long run to be equal while allowing for the short run coefficients and error variances for each cross section to vary; the Mean group estimator (MG) estimator allows all coefficients to vary (Pesaran et al, 1999). The justification for using alternative estimation techniques, such as PMG and MG for data with large time dimensions, is that other panel data estimation techniques such as the generalized method of moments (GMM) may yield inconsistent results with misleading coefficients with large time series data, while PMG and MG are consistent with large cross section and large time series (Pesaran et al., 1999). Similarly, the traditional fixed effects models could produce inconsistent parameters because of the endogeneity between the lagged dependent variable and the error term. However, if the time series component is large, the issue of inconsistent parameters appears to be less of a problem (Pesaran and Smith, 1995).

The pooled mean group estimation is based on a maximum likelihood estimation procedure and it assumes that all the variables are either I (1) or I (0). Assuming the long run money demand function is equation 1, the appropriate lag length is determined using the Akaike Information Criteria (AIC) and the Bayesian Information Criterion (BIC) and the ARDL specified. For example, an ARDL (1,1,1,1,1) would mean rewriting equation 1 as:

$$\begin{aligned} LRM1_{it} = {} & \alpha + \delta_{10}\, INF_{it} + \delta_{11}\, INF_{i,t-1} + \delta_{20}\, LRGDP_{it} + \delta_{21}\, LRGDP_{i,t-1} \\ & + \delta_{30}\, LNER_{it} + \delta_{31}\, LNER_{i,t-1} + \delta_{40}\, FINOV_{it} + \delta_{41}\, FINOV_{i,t-1} \\ & + \lambda LRM1_{i,t-1} + \varepsilon_{it} \end{aligned} \tag{2}$$

which written as an error correction specification is:

$$\begin{aligned} \Delta LRM1_{it} = {} & \phi\big(LRM1_{i,t-1} - \beta_0 - \beta_1\, INF_{it} - \beta_2 LRGDP_{it} - \beta_3 LNER_{it} - \beta_4 FINOV_{it}\big) \\ & - \delta_{11}\, \Delta INF_{it} - \delta_{21}\, \Delta LRGDP_{it} - \delta_{31}\, \Delta LNER_{it} - \delta_{41}\, \Delta FINOV_{it} \\ & + \varepsilon_{it} \end{aligned} \tag{3}$$

where,

$$\beta_0 = \frac{\alpha}{1-\lambda} \qquad \beta_1 = \frac{\delta_{10} + \delta_{11}}{1-\lambda}$$

over the DOLS and FMOLS is that it is more flexible since it allows for homogeneity in the long run coefficients and heterogeneity only in the short run (Roudet et al., 2007). The PMG also allows for the adjustment dynamic between the long run and short run that other panel data methods such as the DOLS and FMOLS do not account for (Bangake and Eggoh, 2012).

$$\beta_2 = \frac{\delta_{20}+\delta_{21}}{1-\lambda} \qquad \beta_3 = \frac{\delta_{30}+\delta_{31}}{1-\lambda}$$
$$\beta_4 = \frac{\delta_{40}+\delta_{41}}{1-\lambda} \qquad \phi = -(1-\lambda)$$

Δ represents first differences, while the error term is represented by ε_{it}. Although Pesaran et al. (1999) do not exclusively test for cointegration, they do make some assumptions for the existence of cointegration. They argue that for a long run relationship to exist, ϕ should not be equal to zero. Although the MG estimator is consistent, it can be biased with misleading coefficient estimates in small samples and PMG estimates may appear more efficient if the parameters are homogeneous (Asteriou and Hall, 2007). To determine the most efficient model, a Hausman test is used. If the null hypothesis of no difference between MG and PMG estimators is rejected, then the PMG estimates are inconsistent and MG estimates are preferred. However, if we fail to reject the null hypothesis then PMG is preferred (Pesaran et al., 1999).

Starting with the dynamic fixed effects estimation procedure for the unbalanced panel, a comparison is made between money demand without financial innovation and with financial innovation. This is followed by the investigation of the effect of financial innovation on money demand using the balanced panel and all the three methods, the DFE, PMG and MG estimators. The exchange rate is then added and the results with and without financial innovation compared.

2.4 Results

Four sets of results are discussed in this section starting with the results for the full sample (unbalanced data) using the Dynamic Fixed Effects (DFE) estimation procedure depicted in Tables 3 and 4 with M2/M1 and alternative proxies of financial innovation used respectively. This is followed by the limited sample (balanced data) results using the pooled mean group (PMG), Mean Group (MG) and DFE estimation procedures depicted in Tables 5 and 6 without and with exchange rates, respectively. This section starts off by assessing the optimum lag length for the PMG and MG models with inclusion and exclusion of exchange rates for the models without and with financial innovation. Using the AIC and BIC lag length criteria tests, it is determined that a maximum lag length of 1 has the smallest AIC and BIC values with inclusion and exclusion of exchange rates, implying that it is the optimum lag length for the PMG and MG regressions as depicted in Table 2 with the inclusion and exclusion of the exchange rate.

Table 2: ARDL Lag Selection

		Without (M2/M1)				With (M2/M1)		
		N	AIC	BIC		N	AIC	BIC
ARDL	**Lag Selection Including exchange rates**							
PMG	ARDL(1,1,1,1)	561	-870.703	-836.066	ARDL(1,1,1,1,1)	561	-1297.431	-1254.134
	ARDL(2,2,2,2)	544	-489.273	-454.881	ARDL(2,2,2,2,2)	544	-1030.594	-987.604
	ARDL(3,3,3,3)	527	155.608	189.745	ARDL(3,3,3,3,3)	527	-447.963	-405.291
MG	ARDL(1,1,1,1)	561	-958.360	923.722	ARDL(1,1,1,1,1)	561	-1461.312	-1418.015
	ARDL(2,2,2,2)	544	-547.136	-512.744	ARDL(2,2,2,2,2)	544	-1144.239	-1101.250
	ARDL(3,3,3,3)	527	106.302	140.439	ARDL(3,3,3,3,3)	527	-524.531	-481.859
ARDL	**Lag Selection Excluding Exchange rates**							
PMG	ARDL(1,1,1)	561	-849.041	-823.062	ARDL(1,1,1,1)	561	-1276.541	-1241.903
	ARDL(2,2,2)	544	-466.395	-440.601	ARDL(2,2,2,2)	544	-976.414	-942.023
	ARDL(3,3,3)	527	171.249	196.852	ARDL(3,3,3,3)	527	-377.944	-343.806
MG	ARDL(1,1,1)	561	-913.201	-887.222	ARDL(1,1,1,1)	561	-1401.589	-1366.951
	ARDL(2,2,2)	544	-498.789	-472.995	ARDL(2,2,2,2)	544	-1063.540	-1029.149
	ARDL(3,3,3)	527	153.417	179.020	ARDL(3,3,3,3)	527	-423.049	-388.911

The first set of results depicted in Table 3 compare the models without financial innovation in columns (1) and (2) to those that include financial innovation (M2/M1) in columns (3) and (4) and those with the exchange rate in columns (2) and (4). Heteroscedasticity is corrected for by adjusting the DFE standard errors with robust standard errors. The specifications for the models seem appropriate and in line with the money demand theory. Inflation is negatively related to money demand in the long run, while income captured by the real GDP has a positive impact on money demand in both the short run and long run (see Table 3)[16]. The variables are all highly statistically significant, except for the exchange rate that is insignificant in the long run and the inflation rate that is insignificant in the short run. The exchange rate is insignificant in the long run, suggesting it does not have a significant impact on money demand. This could be due to the different exchange rate regimes in Sub-Saharan Africa such as the flexible exchange rate regimes in some countries and the fixed exchange rate regimes in others.

These results suggest that financial innovation plays a crucial role in determining money demand in both the long run and the short run, regardless of whether the exchange rate is accounted for or not. Financial innovation is significant at a 1 percent level in both the long run and the short run.

[16] The results are in line with money demand theory and studies such as Hamori (2008) and Salisu et al. (2013) who found a positive and significant effect between income and money demand in Sub-Saharan Africa. In contrast, Suliman and Dafaalla (2011) for Sudan and Bahmani-Oskooee and Gelan (2009) for several African countries found a negative relationship between inflation and money demand.

Table 3: Financial Innovation (M2/M1) and Money Demand (Unbalanced Panel Data 1980-2013)

	Dynamic Fixed Effects(DFE)			
	Without (M2/M1)		With (M2/M1)	
	(1)	(2)	(3)	(4)
Long Run Estimates[17]				
Inflation	-0.026***	-0.035***	-0.027***	-0.036***
	(0.009)	(0.012)	(0.009)	(0.012)
Real GDP	1.460***	1.527***	1.433***	1.493***
	(0.162)	(0.205)	(0.119)	(0.159)
Exchange Rate		-0.017		-0.006
		(0.088)		(0.086)
Financial Innovation(M2/M1)			-0.266***	-0.266***
			(0.068)	(0.072)
Short Run Estimates				
D.Inflation	-0.000	-0.000	-0.000	-0.000
	(0.001)	(0.001)	(0.001)	(0.001)
D.Real GDP	0.281**	0.290**	0.253**	0.262**
	(0.123)	(0.127)	(0.107)	(0.111)
D.Exchange Rate		0.124***		0.138***
		(0.034)		(0.029)
D.Financial Innovation(M2/M1)			-0.267***	-0.272***
			(0.069)	(0.069)
Constant	-1.434***	-1.564***	-1.296***	-1.403***
	(0.317)	(0.331)	(0.267)	(0.260)
Error correction term	-0.130***	-0.126***	-0.131***	-0.125***
	(0.041)	(0.040)	(0.040)	(0.039)
N	993	993	993	993
Number of Countries	34	34	34	34

*Dependent variable: Real M1. *p-value<0.10, **p-value<0.05, ***p-value<0.01 (.) represent the standard errors.*

[17] The long run estimated equations can also be displayed as follows:

Model 1: $LRM1_{it} = \underset{(0.009)***}{-0.026}INF_{it} + \underset{(0.162)***}{1.460}LRGDP_{it}$

Model 2: $LRM1_{it} = \underset{(0.012)***}{-0.035}INF_{it} + \underset{(0.205)***}{1.527}LRGDP_{it} - \underset{(0.088)}{0.017}LNER_{it}$

Model 3: $LRM1_{it} = \underset{(0.009)***}{-0.027}INF_{it} + \underset{(0.119)***}{1.433}LRGDP_{it} - \underset{(0.068)***}{0.266}FINOV_{it}$

Model 4: $LRM1_{it} = \underset{(0.012)***}{-0.036}INF_{it} + \underset{(0.159)***}{1.493}LRGDP_{it} - \underset{(0.086)}{0.006}LNER_{it} - \underset{(0.072)***}{0.266}FINOV_{it}$

As depicted in columns (3) and (4), a unit increase in the ratio of M2 to M1, which is tantamount to an increase in financial innovation, leads to a 26.6 percent decline in money demand in the long run all else constant. Similarly, the short run results depict a negative relationship between financial innovation and money demand of 26.7 percent and 27.2 percent for columns (3) and (4), respectively for each unit increase in the ratio of M2 to M1. The results are in line with the literature and imply that as financial innovation increases, individuals are likely to move away from more liquid assets to less liquid assets, thus leading to a decline in the demand for money.[18]

Although the signs and levels of significance are similar between the models without financial innovation (Table 3, columns 1 and 2) and those with (columns 3 and 4), the coefficients appear to be slightly lower for those with financial innovation. For example, column (1) depicts an inflation coefficient of -0.026 percent compared to -0.027 percent in column (3). The income coefficients also appear to be lower as a one percent increase in GDP leads to a 1.46 percent increase in money demand as indicated in column (1), while column (3) indicates a 1.43 percent increase. Similarly, the short run coefficients of inflation and exchange rates in columns (3) and (4) that capture financial innovation also appear to be smaller than in columns (1) and (2). The results also depict a positive and significant exchange rate in the short run. This suggests that there is evidence of wealth effects, since depreciation in the exchange rate leads to an increase in money demand in the short run.

All the models indicate that the error correction term is negative and significant at a 1 percent level. This confirms that there is cointegration and money demand appears to be stable for Sub-Saharan Africa. All the models, that is, columns (1) to (4), indicate that 13 percent of the disequilibrium is eliminated in each short run period. In other words, the speed of adjustment would take approximately 8 years to return to equilibrium.

[18] The results are similar to Nagayasu (2012) who finds that financial innovation leads to lower money demand in Japan.

Table 4: Results using Alternative Measures for Financial Innovation

	ATMS(2004-2012)		Banks(2004-2012)		Psc(1980-2013)	
	(5)	(6)	(7)	(8)	(9)	(10)
Long Run Estimates[19]						
Inflation	-0.013**	-0.014	-0.026*	-0.025*	-0.033***	-0.045***
	(0.006)	(0.009)	(0.014)	(0.014)	(0.009)	(0.015)
Real GDP	0.885***	0.771**	0.961***	0.956***	1.502***	1.560***
	(0.278)	(0.370)	(0.270)	(0.333)	(0.195)	(0.270)
Exchange Rate		0.086		0.025		0.028
		(0.215)		(0.280)		(0.101)
ATMs Concentration	0.134***	0.151***				
	(0.052)	(0.055)				
Bank Concentration			0.229***	0.241***		
			(0.064)	(0.069)		
Private Sector Credit growth					-0.008	-0.010
					(0.009)	(0.010)
Short Run Estimates						
D.Inflation	0.003**	0.003**	0.002*	0.002*	0.001*	0.001**
	(0.001)	(0.002)	(0.001)	(0.001)	(0.000)	(0.000)
D.Real GDP	0.356	0.404	0.364	0.347	0.285**	0.292**
	(0.252)	(0.290)	(0.244)	(0.242)	(0.120)	(0.127)
D.Exchange Rate		-0.071		-0.069		0.143***
		(0.108)		(0.084)		(0.033)
D.ATMs concentration	-0.024	-0.025				
	(0.033)	(0.034)				
Banks concentration			0.019	0.021		
			(0.062)	(0.062)		
Private Sector Credit growth					0.006***	0.007***
					(0.002)	(0.002)
Constant	0.558	1.639	-0.112	-0.116	-1.313***	-1.367***
	(3.303)	(3.924)	(1.802)	(1.983)	(0.230)	(0.204)
Error correction term	-0.526***	-0.506***	-0.294***	-0.291***	-0.113***	-0.105***
	(0.096)	(0.104)	(0.107)	(0.104)	(0.039)	(0.038)
N	193	193	267	267	945	945
Number of Countries	27	27	30	30	32	32

*Dependent variable: Real M1. *p-value<0.10, **p-value<0.05, ***p-value<0.01 (.) represent the standard errors*

[19] The long run estimated equations can also be displayed as follows:

Model 5: $LRM1_{it} = \underset{(0.006)**}{-0.013INF_{it}} + \underset{(0.278)***}{0.885LRGDP_{it}} + \underset{(0.052)***}{0.134ATMS_{it}}$

Model 6: $LRM1_{it} = \underset{(0.009)}{-0.014INF_{it}} + \underset{(0.370)**}{0.771LRGDP_{it}} + \underset{(0.215)}{0.086LNER_{it}} - \underset{(0.055)***}{0.151ATMS_{it}}$

Model 7: $LRM1_{it} = \underset{(0.014)*}{-0.026INF_{it}} + \underset{(0.270)***}{0.961LRGDP_{it}} + \underset{(0.064)***}{0.229Banks_{it}}$

Model 8: $LRM1_{it} = \underset{(0.014)*}{-0.025INF_{it}} + \underset{(0.333)***}{0.956LRGDP_{it}} + \underset{(0.280)}{0.025LNER_{it}} - \underset{(0.069)***}{0.241Banks_{it}}$

Model 9: $LRM1_{it} = \underset{(0.009)***}{-0.033INF_{it}} + \underset{(0.195)***}{1.502LRGDP_{it}} - \underset{(0.009)}{0.008Psc_{it}}$

Model 10: $LRM1_{it} = \underset{(0.015)***}{-0.045INF} + \underset{(0.270)***}{1.560LRGDP_{it}} + \underset{(0.101)}{0.028LNER_{it}} - \underset{(0.010)}{0.010Psc_{it}}$

While M2/M1 is commonly used in the literature as a broad proxy measure of financial innovation, particularly for developing economies where data is limited, there is the potential problem of endogeneity, as M2/M1 may be correlated to the error term and the demand for money which could influence the negative relationship. Despite these limitations, the results seem to follow the literature on financial innovation. However, for robustness checks, other potential measures of financial innovation, such as ATM concentration, bank concentration as well as private sector credit as a percent of GDP, are considered as depicted in Table 4.

These results (Table 4) indicate that Bank and ATM concentration affect money demand positively in the long run and are insignificant in the short run though correctly signed. This is contrary to what would be expected and could be largely due to the fact that the results may be inconsistent. As mentioned, fixed effects parameter estimates with a lagged dependent variable for small time series are likely to be inconsistent even with large cross sections, though the problem subsides with longer time series (Pesaran and Smith, 1995).

The Bank and ATM data is only available annually for a maximum of 9 years between 2004 and 2012, which is a short time period to determine a long run relationship. The private sector credit as a percentage of GDP is insignificant, suggesting that it is not a good proxy.[20] Nevertheless, other important explanatory variables such as inflation and GDP are significant and have the correct signs in the long run with negative and positive signs respectively for all the models, except inflation in column (6) which is insignificant once the exchange rate is included (see Table 4). In addition, there is evidence of a long run relationship for all the models in Table 4 as the error correction terms are all significant and negative but the speed of adjustment appears to be much faster than in Table 3.

As the results in Table 4 with specific measures of financial innovation appear to be inconsistent, for sensitivity of the results in Table 3, the next set of results focus on the broad measure of financial innovation (M2/M1) using the limited sample (balanced panel) as depicted in Table 5. Similar to Table 3, these results include and exclude financial innovation, but with exclusion of exchange rate for all the three estimation techniques considered, PMG, MG and DFE. To reduce on the inconsistency between the lagged dependent variable and the error term for the DFE, the

[20] As mentioned earlier, despite the use of this measure as a proxy for financial innovation, several studies use private sector credit to GDP to either measure financial intermediation or financial development (see Beck et al., 2000; King and Levine, 1993).

longest time series data available was used. This reduced the number of countries to 17. Heteroscedasticity was also corrected by adjusting the standard errors using robust standard errors for the DFE estimator.

The results for models without financial innovation in columns (11), (12) and (13) are similar to those in Table 3. Inflation and real GDP are both significant at a 1 percent level, with inflation having a negative effect on money demand while income a positive effect. The results for the models with financial innovation in columns (14), (15) and (16) also indicate that income is positive and significant in all three models, while inflation is only significant with the PMG and DFE estimators, and financial innovation is only significant for the PMG and DFE models. The short run results are also similar to Table 3 results with real GDP positive and significant in all the models, inflation insignificant in all the models except for column (15).

When financial innovation is included, it has a negative sign in the short run, with a significance level of 1 percent. The error correction terms are all significant and negative, implying that cointegration indeed exists and money demand appears to be stable. The error correction terms do vary, with MG having the fastest speed of adjustment of 14-17 percent, which implies it takes about 6-7 years to return to equilibrium. The DFE, has an ecm term of 6-7 percent while the PMG has an ecm term of 6 percent, implying that it takes about 17-25 years and 17 years respectively for the disequilibrium to be eliminated in each short run period from the DFE and PMG estimators. Unlike the MG estimation results, the PMG and DFE results give smaller coefficients when financial innovation is included. This is similar to the full sample results in Table 3.

Table 5: Financial Innovation (M2/M1) and Money Demand Excluding Exchange Rate (Balanced Panel Data 1980-2013)

	Without (M2/M1)			With (M2/M1)		
	(11)	(12)	(13)	(14)	(15)	(16)
	PMG	MG	DFE	PMG	MG	DFE
Long Run Estimates[21]						
Inflation	-0.088***	-0.051***	-0.053***	-0.116***	-0.052	-0.062***
	(0.026)	(0.014)	(0.015)	(0.031)	(0.098)	(0.014)
Real GDP	1.700***	1.995***	1.782***	1.107***	2.492***	1.567***
	(0.242)	(0.308)	(0.344)	(0.167)	(0.882)	(0.214)
Financial Innovation(M2/M1)				-0.148***	-4.078	-0.187*
				(0.053)	(2.742)	(0.100)
Short Run Estimates						
D.Inflation	0.000	0.001	0.001	0.001	0.002**	0.000
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)
D.Real GDP	0.721***	0.473***	0.600***	0.595***	0.366***	0.534***
	(0.154)	(0.136)	(0.119)	(0.117)	(0.127)	(0.118)
D.Financial Innovation(M2/M1)				-0.575***	-0.514***	-0.230***
				(0.113)	(0.109)	(0.060)
Constant	-0.972***	-2.686***	-1.312***	-0.169***	-1.210*	-0.862**
	(0.161)	(0.694)	(0.467)	(0.057)	(0.690)	(0.366)
Error correction term	-0.059***	-0.169***	-0.069***	-0.058***	-0.137***	-0.064***
	(0.010)	(0.027)	(0.022)	(0.009)	(0.046)	(0.020)
N	578	578	578	578	578	578
Number of Countries	17	17	17	17	17	17
Hausman Test	2.23 [a]	0.00 [a]		0.62 [b]	0.00 [b]	
Log-Likelihood	430.520	462.600		646.271	708.795	

*Dependent variable: Real M1. *p-value<0.10, **p-value<0.05, ***p-value<0.01 (.) represent the standard errors .* [a] *represents the Hausman Test* $\chi^2_{(2)}$ *for models that exclude financial innovation and* [b] *represents the Hausman test* $\chi^2_{(3)}$ *for models that include financial innovation.*

[21] The long run estimated equations can also be displayed as follows:

Model 11: $LRM1_{it} = \underset{(0.026)***}{-0.088}INF_{it} + \underset{(0.242)***}{1.700}LRGDP_{it}$

Model 12: $LRM1_{it} = \underset{(0.014)***}{-0.051}INF_{it} + \underset{(0.308)***}{1.995}LRGDP_{it}$

Model 13: $LRM1_{it} = \underset{(0.015)***}{-0.053}INF_{it} + \underset{(0.344)***}{1.782}LRGDP_{it}$

Model 14: $LRM1_{it} = \underset{(0.031)***}{-0.116}INF_{it} + \underset{(0.167)***}{1.107}LRGDP_{it} - \underset{(0.053)***}{0.148}FINOV_{it}$

Model 15: $LRM1_{it} = \underset{(0.098)}{-0.052}INF_{it} + \underset{(0.882)***}{2.492}LRGDP_{it} - \underset{(2.742)}{4.078}FINOV_{it}$

Model 16: $LRM1_{it} = \underset{(0.014)***}{-0.062}INF_{it} + \underset{(0.214)***}{1.567}LRGDP_{it} - \underset{(0.100)*}{0.187}FINOV_{it}$

Given that PMG and DFE have higher precision and coefficients of similar magnitude in contrast to MG, which has less precision and a higher speed of adjustment, some further investigation was undertaken. The Hausman test indicated that the PMG for this case was more efficient than the MG and the null hypothesis of no difference between the MG and PMG estimators for the models with financial innovation and those without could not be rejected. This could be the result of the limited number of observations, or that the PMG assumption of homogeneous long run parameters is correct (Asteriou and Hall, 2007; Pesaran et al., 1999). Since fixed effects models are likely to have simultaneity bias due to the relationship between the error term and the lagged dependent variable, the extent of this bias was tested using the Hausman test between MG and DFE. The null is not rejected at a 1 percent level of significance. This implies that there is indeed relatively low bias and the DFE results are preferred to the MG results (Blackburne and Frank, 2007).

The final set of results depicted in Table 6 follow similar regression specifications as in Table 5, but with addition of the exchange rate and using robust standard errors for the DFE results. The long run results are less consistent across the different methods, but the inflation rate and real GDP are significant and with the appropriate negative and positive signs respectively for all the models. As in Table 3, the exchange rate is insignificant in almost all the regressions, except for the PMG results in column (17), where it is positive and significant. Financial innovation is negative and highly significant, with the coefficients much larger than in Tables 3 and 5. Also, the inclusion of financial innovation no longer appear to give slightly lower coefficients, but markedly different coefficients.

In terms of the short run results, financial innovation and the real GDP are statistically significant at a 1 percent level and are negatively and positively related to money demand respectively as economic theory predicts. Inflation is insignificant and the exchange rate is only significant and positive with the use of DFE estimation. This finding is similar to the results in Table 3. As seen in previous results, there is also evidence of a long run relationship between money demand and its determinants with the error correction terms all significant and negative in Table 6. The fastest speed of adjustment recorded by the MG models with 16-18 percent per year, followed by DFE and PMG at 7 percent and 2-4 percent, respectively.

Table 6: Financial Innovation (M2/M1) and Money Demand Including Exchange Rate (Balanced Panel Data 1980-2013)

	Without (M2/M1)			With (M2/M1)		
	(17)	(18)	(19)	(20)	(21)	(22)
	PMG	MG	DFE	PMG	MG	DFE
Long Run Estimates[22]						
Inflation	-0.140***	-0.050***	-0.058***	-0.209**	-0.140*	-0.072***
	(0.051)	(0.017)	(0.014)	(0.103)	(0.079)	(0.015)
Real GDP	0.720*	1.239***	2.036***	2.611***	2.818**	1.768***
	(0.408)	(0.421)	(0.439)	(0.702)	(1.385)	(0.319)
Exchange Rate	0.462**	0.291	-0.108	0.268	-2.082	-0.054
	(0.213)	(0.257)	(0.112)	(0.265)	(1.914)	(0.106)
Financial Innovation(M2/M1)				-3.851**	-3.877*	-0.187**
				(1.852)	(2.318)	(0.093)
Short Run Estimates						
D.inflation	0.000	-0.000	0.001	-0.000	0.001	0.000
	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)
D.Real GDP	0.688***	0.451***	0.630***	0.554***	0.346***	0.557***
	(0.195)	(0.147)	(0.111)	(0.149)	(0.115)	(0.110)
D.Exchange rate	-0.014	-0.017	0.086***	0.008	-0.017	0.100***
	(0.062)	(0.069)	(0.024)	(0.058)	(0.056)	(0.019)
D.Financial Innovation(M2/M1)				-0.570***	-0.517***	-0.231***
				(0.106)	(0.112)	(0.060)
Constant	0.177***	-1.980**	-1.810***	-0.639***	-1.186*	-1.163***
	(0.040)	(0.962)	(0.586)	(0.136)	(0.716)	(0.428)
Error correction term	-0.040***	-0.180***	-0.074***	-0.022***	-0.156***	-0.065***
	(0.010)	(0.025)	(0.016)	(0.005)	(0.047)	(0.015)
N	578	578	578	578	578	578
Number of Countries	17	17	17	17	17	17
Hausman Test	0.92 [c]	0.01 [c]		1.78 [d]	0.01 [d]	
Log-Likelihood	443.352	487.180		658.715	740.656	

*Dependent variable: Real M1. *p-value<0.10, **p-value<0.05, ***p-value<0.01 (.) represent the standard errors.* [c] *represents the Hausman Test* $\chi^2_{(3)}$ *for models that exclude financial innovation and* [d] *represents the Hausman test* $\chi^2_{(4)}$ *for models that include financial innovation*

[22] The long run estimated equations can also be displayed as follows:

Model 17: $LRM1_{it} = \underset{(0.051)***}{-0.140INF_{it}} + \underset{(0.408)*}{0.720LRGDP_{it}} + \underset{(0.213)**}{0.462LNER_{it}}$

Model 18: $LRM1_{it} = \underset{(0.017)***}{-0.050INF_{it}} + \underset{(0.421)***}{1.239LRGDP_{it}} + \underset{(0.257)}{0.291LNER_{it}}$

Model 19: $LRM1_{it} = \underset{(0.014)***}{-0.058INF_{it}} + \underset{(0.439)***}{2.036LRGDP_{it}} - \underset{(0.112)}{0.108LNER_{it}}$

Model 20: $LRM1_{it} = \underset{(0.103)**}{-0.209INF_{it}} + \underset{(0.702)***}{2.611LRGDP_{it}} + \underset{(0.265)}{0.268LNER_{it}} - \underset{(1.852)**}{3.851FINOV_{it}}$

Model 21: $LRM1_{it} = \underset{(0.079)*}{-0.140INF_{it}} + \underset{(1.385)**}{2.818LRGDP_{it}} - \underset{(1.914)}{2.082LNER_{it}} - \underset{(2.318)*}{3.877FINOV_{it}}$

Model 22: $LRM1_{it} = \underset{(0.015)***}{-0.072INF_{it}} + \underset{(0.319)***}{1.768LRGDP_{it}} - \underset{(0.106)}{0.054LNER_{it}} - \underset{(0.093)}{0.187FINOV_{it}}$

PMG is preferred to MG according to the Hausman test, while DFE is preferred to MG regardless of whether financial innovation was included or not. Although the results are not as robust in terms of the level of significance in comparison to Table 5 results, the MG results with financial innovation seem to have improved with inclusion of the exchange rate. Comparing Tables 3, 5 and 6 shows that the PMG and DFE results appear closer than the MG results.

Overall, the results from all the models suggest that financial innovation has a significant effect on the demand for money in Sub-Saharan Africa. It is negatively related to money demand in both the long run and the short run, regardless of the estimation method used. Most importantly, the coefficients of the traditional money demand determinants appear to be sensitive to the addition of financial innovation, with most results showing a decline in coefficients. This may imply that the exclusion of this variable could indeed lead to biased or misleading estimates of the money demand equation.

2.5 Conclusion

The relationship between financial innovation and money demand is important especially in the implementation of monetary policy and it has been widely researched. However, few studies have focused on Sub-Saharan African countries, and those that have are generally country case studies. This chapter tried to fill the gap in the literature by investigating the relationship between financial innovation and money demand in 34 Sub-Saharan African countries between 1980 and 2013 using panel data estimation techniques.

Financial innovation was found to be an important variable in determining money demand and to have a negative effect on the demand for money in both the long run and the short run. This supports the expectation that the growth in financial innovation has led individuals to move away from more liquid assets to less liquid ones, and that this lowers the demand for money. These results are in line with most of the literature that finds a negative relationship between financial innovation and money demand (See Nagayasu 2011, Lippi and Secchi 2009).

The traditional determinants for money demand, such as the opportunity cost of holding money and income were negatively and positively related to money demand respectively as expected.

These results are in line with money demand theory, and studies such as Hamori (2008) and Salisu et al. (2013) who found a positive and significant effect between income and money demand in Sub-Saharan Africa, and Suliman and Dafaalla (2011) for Sudan and Bahmani-Oskooee and Gelan (2009) for several African countries who found a negative relationship between inflation and money demand. Comparing the models with and without financial innovation showed differing coefficient estimates for inflation and income, as the coefficients appeared to be slightly lower for the models with financial innovation. This suggests that excluding financial innovation, may have led to biased estimates in previous studies that excluded financial innovation.

Introducing the exchange rate into the model did not suggest it plays a major role in determining money demand in the long run. This could be due to the fact that countries with different exchange rate regimes were included in the sample and some more detailed case study investigation of this would be valuable. There was some evidence of stability, with all of the error correction terms negative and significant, though the speed of adjustment varied across the different methods.

These results have important policy implications for future policy design given the development of new financial innovations, such as mobile money, in the region. Not accounting for financial innovation means money demand models will not be well specified and can produce biased estimates. While some Sub-Saharan African countries such as Ghana, Uganda and South Africa have moved towards inflation targeting, others retain monetary targets. Monetary aggregates still remain relevant in guiding policy makers. A stable and well specified demand function is an important input into such decision making processes.

There are, of course, limitations to the analysis undertaken in this study, most of which are shared with other studies of money demand. Differences in the types of financial innovations across African countries suggest that using general proxies such as M2/M1 to measure financial innovation may not be adequate. What is true for the region may not necessarily be true for a particular country. A good example of this is the growth of mobile money in countries such as Kenya, Tanzania, and Uganda. Further work may need to be done using country case studies to investigate the effect of a specific type of financial innovation on money demand rather than relying on the broader measures of financial innovation.

Appendix A

Table A1 :Sub-Saharan African Countries

Unbalanced Panel :		Balanced Panel: (1980-2013)
Benin (1993-2013)	Mali (1989-2013)	Botswana
Botswana (1980-2013)	Mauritius (1980-2013)	Burkina Faso
Burkina Faso (1980-2013)	Mozambique(1989-2013)	Burundi
Burundi (1980-2013)	Namibia (2003-2013)	Cameroon
Cabo Verde (1984-2013)	Niger (1980-2013)	Cote d'Ivoire
Cameroon (1980-2013)	Nigeria (1980-2013)	Gambia, The
Central African Republic (1981-2013)	Sao Tome and Principe (2000-2013)	Ghana
Chad (1984-2013)	Senegal (1980-2013)	Kenya
Comoros (2001-2013)	Seychelles (1980-2013)	Mauritius
Cote d'Ivoire (1980-2013)	South Africa (1980-2013)	Niger
Equatorial Guinea (1986-2013)	Sudan (1980-2013)	Nigeria
Gabon (1980-2013)	Swaziland (1980-2013)	Senegal
Gambia, The (1980-2013)	Tanzania(1988-2013)	Seychelles
Ghana (1980-2013)	Togo (1980-2013)	South Africa
Guinea-Bissau (1988-2013)	Uganda (1994-2013)	Sudan
Kenya (1980-2013)		Swaziland
Liberia (2002-2013)		Togo
Madagascar (1980-2013)		
Malawi (1981-2013)		

Table A2: Variable Description

Variable Name	Description	Abbreviation
Real M1	log of (M1/CPI)	LRM1
Inflation	Inflation based on CPI	INF
Real GDP	log of GDP at constant 2005 US$	LGDP
Nominal Exchange Rate	log of the average local currency per US$	LNER
Financial Innovation(M2/M1)	M2/M1	FINOV
Financial Innovation(psc)	domestic credit to private sector by banks as a percentage of GDP	PSC
Financial Innovation(ATMs)	Log of Automated Teller Machines per 100,000 adults	LATMS
Financial Innovation(Banks)	Log of commercial bank branches per 100,000 adults	LBANKS

Source: World Bank Data Bank (2015)

Chapter 3

Mobile Money and Money Demand in Kenya

3.1 Introduction

Given the importance of the stability of money demand in the successful implementation of monetary policy, considerable research has been conducted worldwide.[23] Most of the earlier studies in both advanced – e.g. Brunner and Meltzer (1963) and Meltzer (1963) for the US – and developing economies – e.g. Mwega (1990) and Adam (1992) for Kenya – found that the demand for money is stable, in the sense that the monetary authority can effectively control inflation through adjusting the money supply, while instability of the money demand can hinder the proper monitoring of prices (Hamori, 2008). Although studies prior to mid-1970s relied on a limited number of variables such as interest rates and income to achieve a stable money demand, during the last few decades financial innovation has led researchers to re-examine the stability of money demand by incorporating various financial innovations in the money demand specification. This is primarily because failure to account for financial innovations can potentially lead to the misspecification of the money demand and hinder monetary policy.

As indicated in a number of studies, financial innovation is often difficult to measure[24]. The various measures of financial innovation include, the number of ATMS, debit cards, a ratio of M2 to M1 just to mention a few. Although most financial innovations originate from developed countries (particularly the US and the UK), mobile money (M-PESA), a rather unique type of financial innovation, was developed and introduced in Kenya by Safaricom, a mobile network operator, in 2007. M-PESA provides customers with a variety of services, including depositing, transferring or withdrawing funds as well as paying bills and purchasing goods or services using cell phone technology without the use of a bank account (Jack and Suri, 2011; Jack et al., 2010).

[23] See inter alia Darrat (1985), Adam (1992), Hoffman et al. (1995), Bahmani-Oskooee (2001), and Bahmani-Oskooee and Gelan (2009).

[24] There are several definitions of financial innovation, for example, Arrau and De Gregorio (1991) define financial innovation to include both technological processes and financial regulation or deregulation. In addition, Melnick and Yashiv (1994,p.2) refer to financial innovation as "introduction of new liquid assets that partially replace traditional money in agent's portfolios, technological progress in banking services that reduces the costs of transactions and changes in the regulatory environment that facilitate transactions." Furthermore, Arrau et al. (1995) refer to financial innovation as permanent changes to the money demand that are not caused by opportunity cost i.e. interest rates and scale variables such as GDP or consumption for the case of a household money demand.

Although mobile money started off as a payment system mainly used for sending and receiving remittances, it has quickly evolved and it is being used by both the banked and the unbanked population. Most importantly, individuals can now get loans based on credit history from M-PESA (Safaricom, 2014). Individuals who would otherwise not have had access to financial services can now do so with easier access through an alternative form of cash, mobile money.

Mobile money differs from other financial innovations since a bank account is not required to access financial services and thus its impact on money demand is likely to be different. The sign of financial innovation on the money demand specification varies, and it is highly dependent on the proxy used. While most of these innovations are often expected to have a negative effect on money demand, because individuals move away from holding cash to assets and as a result they demand less money, the sign of mobile money is likely to be either positive or negative. On the one hand, mobile money is initially expected to lead to a positive effect on money demand since it includes the use of cash, and an alternative form of cash, (e-money), that is not necessarily an alternative form of asset other than cash, individuals are likely to demand more money. Individuals who would otherwise not have had access to financial services can now do so because of this innovation. These individuals include those that used to keep their money under the mattress, or those who were involved in barter trade prior to the introduction of mobile money. So, as mobile money usage increases, demand for money is likely to increase as well. On the other hand, as mobile money usage continues to grow, transactions costs are likely to decline, making it much easier for both the banked and unbanked individuals to carry out financial transactions, and for the unbanked to have access to additional financial facilities that they would otherwise not have had. As a result, individuals may demand less money as they start investing in other assets other than cash. This implies that the sign of mobile money on money demand can only be determined empirically as it could either be negative or positive depending on which effect is greater.

Kenya is of specific interest in this study because it was the first country to introduce mobile money. In addition, it has the largest number of mobile money users in the world. While Davidson and Pénicaud's (2012) worldwide mobile money survey indicates that 80 percent of 2011 mobile money transactions were processed in East Africa, Allen et al. (2014) indicate that 61 and 67 percent of the 2011 adult population in Kenya were using their mobile phones to send

and receive remittances respectively. Moreover, Kenya, Uganda, Madagascar and Tanzania have more registered mobile money users than bank accounts (Pénicaud, 2013). Therefore, failure to account for mobile money could complicate monetary policy effectiveness especially for the Central Bank of Kenya (CBK) that conducts monetary policy based on monetary aggregate targeting. While the CBK uses the Net Domestic Assets and Net International reserves as the operational parameters, and monitors M3 and the private sector credit (see CBK Monetary Policy Statement, 2014b), they started the process of transitioning from monetary aggregate targeting to a more forward looking monetary policy in 2011, in order to gradually move towards inflation targeting (IMF 2015). A vital question that is still worth investigating is whether the demand for money is stable, given the recent financial innovation developments in Kenya. To the best of my knowledge, there is no study that investigates the stability of the Kenyan money demand considering this unique financial innovation, mobile money. There are only two studies that attempt to capture the effect of financial innovation on the Kenyan money demand but both use different proxies for financial innovation for example, Sichei and Kamau (2012) use the number of ATMs while and Ndirangu and Nyamongo (2015) use the currency outside banks/time deposit ratio.

This chapter contributes to the literature by re-estimating the Kenyan money demand including the country specific innovation, mobile money. Various measures of mobile money are used to capture this relationship using the ARDL approach to cointegration over the period 2000 Q1 to 2014 Q2. The rest of the chapter is structured as follows. A review of the theoretical and empirical literature is given in Section 3.2 followed by a brief overview of the Kenyan financial system and financial innovations in Section 3.3. Then, section 3.4 presents the data, the model specification and the estimation method. Finally, the results and conclusions are discussed in sections 3.5 and 3.6 respectively.

3.2 Literature Review

In theory, financial innovations can improve the banking sector's efficiency through the reduction in transaction costs. However, it can also complicate the way monetary policy is conducted due to the instability of the money demand. To achieve the ultimate goal of price

stability, Central Banks, particularly those that target monetary aggregates, require a stable money demand function. The stability of money demand plays a crucial role in the conduct of monetary policy, especially in terms of the appropriate monetary policy actions (Sriram, 2000). Several theories that explain money demand have been developed over the years. As discussed in chapter two, older theories that are based on the quantity theory of money developed by classical economists, assume that the velocity of money is stable and that the primary determinant of money demand is income. This theory has advanced over time with modifications by Keynesians who incorporate the interest rate and refer to money demand theory as the liquidity preference theory. The modifications include three motives of holding money, namely, the transaction/business motive, the precautionary motive and the speculative motive (for a detailed review of these theories, see Serletis, 2007).

New money demand theories 'post-Keynes' were also developed; for instance, the transactions and portfolio theories (Sriram, 1999). Transactions theories, such as the Baumol-Tobin model, the shopping time model and cash in advance model, assume that money serves as a medium of exchange, while portfolio theories, such as Tobin's theory of liquidity preference and the overlapping generations models, assume the role of money as a store of value (Serletis, 2007).

In terms of empirical work, money demand specification has received a lot of attention over the years, partly due to the contradictory results regarding the stability of money demand. There are various reasons that could lead to the instability[25] of money demand, such as changes in regulations, financial and monetary reforms or developments in financial innovation which could lead to an unstable money demand and unpredictable velocity. The instability of money demand may also be due to the inadequacy of the partial adjustment modelling technique or perhaps new financial innovation (Sriram, 1999).

As a result of growth in financial innovation over the last few years, several empirical studies have started including financial innovation in the money demand specification.[26] Exclusion of

[25] Andersen (1985) highlights three sources of instability. These are first, a change in income velocity as a result of fluctuations in interest rates and other factors not related to income. Second, money stocks that may not correspond to money balances desired in the short run which could lead to unexpected changes in velocity. Third, a shift in the money demand function implying unstable parameters or new developments such as financial innovation.

[26] Some studies attempt to capture the relationship between financial innovation and money demand by considering money as a medium of exchange. For example, Ireland (1995) incorporates financial innovation into the cash in advance theoretical model, while Alvarez and Lippi (2009) and Attanansio et al. (2002) use the Baumol-Tobin

financial innovation in the money demand function could lead to misspecification of the money demand through over estimation, commonly referred to as 'missing money' (Arrau and De Gregorio, 1991). Empirical evidence suggests that financial innovation ought to be included in the money demand function to help solve some of the issues faced by money demand specification, such as autocorrelated errors, persistent over prediction and implausible parameter estimates (Arrau et al., 1995). In addition, non-stationary processes such as financial innovation, could explain the failure of cointegration of the money demand. However, once financial innovation is accounted for, periods of 'missing money' are eliminated (Arrau and De Gregorio, 1991).

Finding the appropriate measure to capture financial innovation is difficult as discussed in chapter two. As a result, several proxies such as a dummy variable, ATM concentration, bank concentration, and M2/M1 have been considered in the literature.[27] Most of the studies that have accounted for financial innovation in the money demand specification mainly focus on advanced and transition economies (Arrau and De Gregorio, 1993; Attanasio et al., 2002; Nagayasu, 2012). This is partly due to the fact that most financial innovations in the last few decades occurred in developed countries. However, there is remarkable progress in financial innovation in developing countries as well, given the new regulations, improved banking systems, financial markets, and increased cell phone usage. Studies that have attempted to analyse the relationship between financial innovation and money demand in developing countries inter alia include, Arrau et al. (1995), Mannah-Blankson and Belyne (2004), Hafer and Kutan (2003) and Hye (2009). Empirical findings on the relationship between financial innovation and money demand

model to capture the role of financial innovation on money demand. However, other studies have incorporated financial innovation to the traditional money demand function by directly using different proxies of financial innovation. These include inter alia, Arrau et al. (1995), Nagayasu (2012), Hafer and Kutan (2003), Arrau and De Gregorio (1993), Mannah-Blankson and Belyne (2004), and Sichei and Kamau (2012).

[27] For example, Hafer and Kutan (2003) and Augustina et al. (2010) used a dummy variable to account for shifts in the money demand on account of financial innovation for the case of the Philippines and Nigeria respectively. Arrau and DeGregorio (1991) modelled financial innovation as shocks that follow a random walk that lead to permanent changes to the money demand not explained by the opportunity cost of holding money or income. Although stochastic or deterministic trends offer a plausible proxy for financial innovation that eliminates the misspecification in the traditional money demand function, Arrau et al. (1995) argue that it may be too general to identify the specific origin of the innovation. For developed countries, the number of ATMs is commonly used as a proxy for financial innovation (e.g. Fischer's, 2007 study for Switzerland; Lippi and Secchi, 2009 and Attanasio et al., 2002 studies for Italy). Also, Nagayasu (2011) among several measures of financial innovation for his panel data analysis, used bank concentration measured as a ratio of the number of banks to the total population which would be similar to using the number of ATMs captured by Fischer (2007). Other studies have used different proxies for financial innovation. For example, Michalopoulos et al. (2009) measure financial innovation as growth rate of private credit/GDP, while Arrau et al. (1995) use a time trend and a stochastic trend to measure financial innovation in developing countries.

mainly indicate a negative effect (Lippi and Secchi, 2009; Attanasio et al., 2002), however, a few studies depict a positive relationship between money demand and financial innovation (Hye, 2009; Mannah-Blankson and Belyne, 2004). The mixed findings can be partly explained by the different proxies of financial innovation considered in these studies. This suggests that financial innovation could have a negative or positive effect depending on the measure of financial innovation used.

Kenya is no exception to new financial innovations particularly after 2007, when mobile money was introduced. Given this, it has become even more vital to capture the relationship between financial innovation and money demand.[28] One attempt by Sichei and Kamau (2012) to account for financial innovation in the money demand function for Kenya used the number of ATMs as a proxy for financial innovation and found that it only had an impact on M1, but no evidence was found for the other measures of money. Similarly, Ndirangu and Nyamongo (2015) also found no effect of financial innovation on money demand using currency outside banks/time deposit ratio as a proxy for financial innovation. However, Weil et al. (2012) who used Safaricom data to compute M-PESA velocity, found that mobile money has a minor systematic effect on monetary policy in Kenya due to the fact that mobile money is sufficiently small. They, however, argued that this conclusion may change in the future as mobile money progresses to more than a payment platform hence increasing the number and transaction value of mobile money. A shortcoming of these Kenyan studies is that they fail to proxy financial innovation using mobile money usage in the money demand specification, despite it being one of the latest innovations that has been growing rapidly in Kenya.

Apart from financial innovation, other typical determinants of money demand include interest rates, exchange rates and income. The interest rate is often negatively related to the money demand. The debate is mainly centred on the type of interest rate used, that is, whether long term or short term interest rates. For example, Bahmani-Oskooee and Bohl (2000) use the long-term government bond yield for Germany and Hafer and Kutan (2003) 91-TBILL rate for the Philippines. For the case of Kenya, most studies have so far used the Treasury bill rate to capture

[28] Instability of money demand in Kenya could be due to recent financial innovations such as the mobile money platforms (Central Bank of Kenya, 2014b). According to the June 2014 monetary policy statement, it has become more difficult to predict money demand due to unstable money multiplier and falling velocity.

the return on alternative assets and the deposit rate to capture the return on domestic asset (see Kiptui, 2014; Sichei and Kamau, 2012). These studies all depict a negative relationship between the opportunity cost of holding money and money demand. Based on the theory from the Bahmol-Tobin Model, the interest rate elasticity of money demand is approximately 0.5.

Income, one of the main determinants of money demand is often captured using Gross Domestic Product (GDP). Most studies find that income and money demand are positively related, but the size of the income elasticity tends to vary among the studies.[29] For example, Suliman and Dafaala (2011) find that income elasticity is approximately 1 for the case of Sudan, while Adam (1992) and Mwega (1990) find income elasticity greater than 1 and less than 1 respectively in Kenya.

An extension of the money demand specification in some studies usually includes the exchange rate. The exchange rate measures a country's competitiveness with other countries. While an appreciation of the exchange rate decreases a country's competitiveness, a depreciation would increase its competitiveness. Exchange rates have two effects on money demand: a substitution effect and a wealth effect. A substitution effect occurs when a depreciation of the exchange rate leads to a reduction in the demand for money. This occurs due to the substitutability of domestic currency for foreign currency or bonds because there are higher returns from holding foreign money (Sriram, 2000).The agents might hold onto these foreign assets to protect their portfolio and as a result money demand declines. In other words, the confidence in the domestic exchange rate is lowered due to the depreciation and as a result, money demand declines through a substitution effect with foreign money (Dreger et al, 2007). A wealth effect occurs when a depreciation of the exchange rate leads to an increase in money demand. In other words, a depreciated exchange rate would imply an increase in foreign assets by domestic residents and thus a rise in wealth (Dobson and Ramlogan, 2001). This increase in the demand of goods from abroad due to the depreciated exchange rate could lead to higher inflation and a higher demand for money due to the increase in the number of transactions (Dreger et al, 2007). Although few studies have considered including the exchange rate in the money demand specification for Kenya, Kiptui (2014) included it and found a negative effect on money demand.

[29] The Bahmol-Tobin model predicts a 0.5 coefficient on income while the quantity theory of money predicts an income elasticity of approximately 1 (Serletis, 2007)

While econometric techniques such as Johansen and Juselius, and Engel and Granger have been used in money demand literature, recent studies have also considered the autoregressive distributed lag (ARDL) approach to cointegration. For example, Bahmani-Oskooee and Gelan (2009), Kiptui (2014) and Ndirangu and Nyamongo (2015) for the case of Kenya employ the ARDL. A limitation in these studies, however, is failure to account for financial innovation particularly mobile money in the money demand specification. The exception is Ndirangu and Nyamongo (2015) who used the currency outside banks/time deposit ratio as a proxy for financial development. This chapter overcomes this limitation by incorporating mobile money in the money demand specification. Prior to the empirical analysis, it is useful to know the main features of the Kenyan financial system and this is done in the next section.

3.3 An Overview of the Kenyan financial system and financial innovations

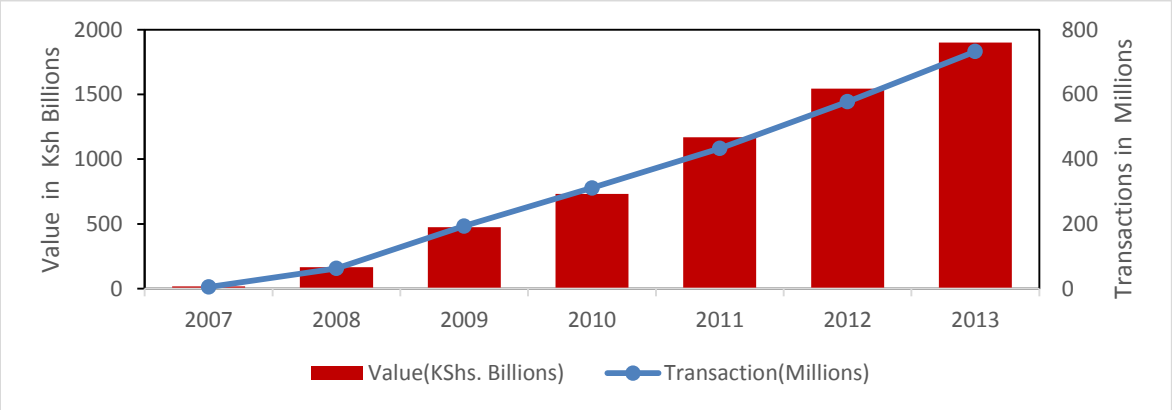
In the last two decades, Kenya experienced several financial reforms to enhance the financial sector and boost economic growth. This could partly explain the development of various financial innovations and, particularly, mobile money within the last decade. The deregulation in the 1990s and improved technology in the communications industry enhanced financial services. Kenya has transformed its payment system over time, starting with the automation of the Nairobi clearing house in 1998, followed by the Electronic Funds Transfer (EFT), and the 2005 launch of the Kenya electronic payments and settlement system (KEPSS), is a Real Gross Time Settlement (RTGS) system (Central Bank of Kenya, 2014a) and more recently mobile money adoption.

Mobile money (M-PESA) is a type of financial innovation that was first introduced in Kenya in 2007 by Safaricom, a mobile network operator. M-PESA provides customers with a variety of services, including depositing, transferring or withdrawing funds as well as paying bills and purchasing goods or services using cell phone technology without the use of a bank account (Jack and Suri, 2011; Jack et al., 2010). Although it is popularly used for sending and receiving remittances, Jack and Suri (2011) argue that mobile money was not necessarily designed to replace all payment systems. In addition to the financial reforms, another possible reason for the development and success of mobile money is the wide spread use of cell phones in Kenya. Indeed, Weil et al. (2012) argue that this rapid increase in the mobile phone network enabled

adoption of mobile money services such as M-PESA. Mobile phones not only reduce communication costs, but could potentially evolve into service delivery platforms as markets mature in Africa (Aker and Mbiti, 2010). While several African countries have also benefited from the wide spread use of cell phones, they have not been as successful as Kenya in mobile money usage. As argued by Allen et al. (2014), despite the rapid growth in mobile banking in Africa compared to other developed countries, it has only been successful in the sending and receiving of remittances.

The Kenyan success story could be partially explained by the good working relationship Safaricom has with the Central Bank of Kenya, which has enabled it to develop the mobile money product that could suit the market and facilitate the rapid growth in mobile money services (Mas and Radcliffe, 2011). Since its introduction, mobile money has grown rapidly with 65 percent of Kenyan households using this product (Jack and Suri, 2011). In addition, the percentage of the adult population in Kenya using their mobile phones to send and receive remittances had grown to 61 percent and 67 percent in 2011, respectively (Allen et al., 2014). Mobile money has continued to grow rapidly in Kenya. For example, the total value of mobile money transactions rose from 16 billion Kenya shillings ($248 million) in 2007 to 1.9 trillion Kenya Shillings (US$22 billion) in 2013. Similarly, the total number of mobile money transactions rose from 5.47 million in 2007 to 733 million in 2013 (see Figure 3).

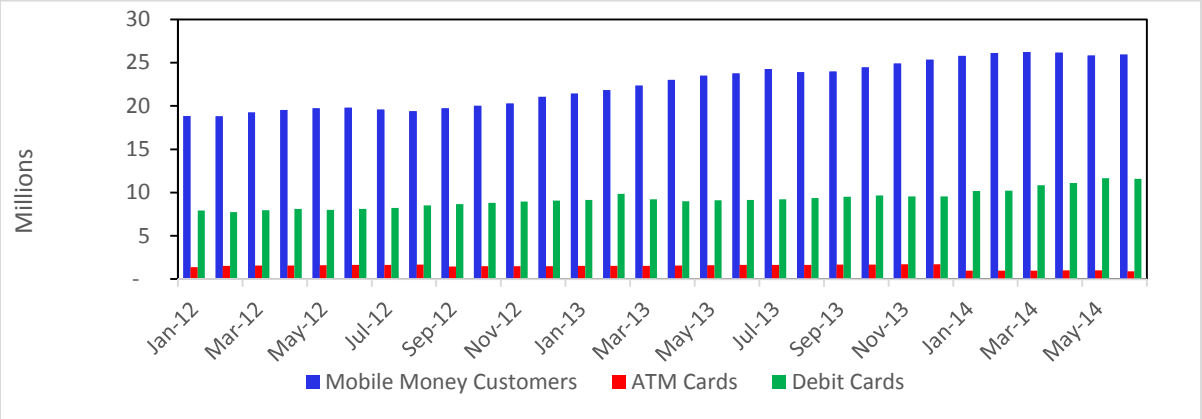
Figure 3: Trend in the Mobile Money values and number of transactions in Kenya (2007-2013)



Source: Central Bank of Kenya (2014a)

Within a short period of time, more Kenyans have had access to financial services through the use of this new technology mobile money. Indeed, the number of mobile money users currently surpass the number of ATM and debit cards as indicated in Figure 4. The number of registered customers in Kenya also increased to 25.9 million by June 2014 compared to only 21,000 customers at the start of mobile money in March 2007. Since the population of Kenya stands at 45 million people (Central Intelligence Agency, 2014), it implies that the number of mobile money customers is higher than half the population of Kenya. More importantly, mobile money is likely to have a larger effect on the financial system than other payment systems, especially in terms of reaching out to the unbanked population that would otherwise not have been able to access financial services.

Figure 4: Comparison Between Mobile Money customers, ATM and Debit Cards (2012-2014)



Source: Central Bank of Kenya (2014a)

Interestingly, empirical findings suggest that M-PESA users are more likely to be banked, educated and wealthier than non-users (Aker and Mbiti, 2010). The fact that mobile money users are more likely to be banked implies that commercial banks are also increasingly working together with telecom companies to improve financial services, despite the fact that a bank account is not needed for mobile money usage. For example, Safaricom's M-PESA account holders can easily transfer money between their M-PESA accounts and their bank accounts directly or through the use of an ATM (Jack and Suri, 2011). Mobile money is continuously evolving. For instance, Kenya's largest telecom company, Safaricom, adopted M-shwari in 2012 in addition to M-PESA. M-shwari is a paperless bank account that can be accessed through mobile phones. One can earn interest and get loans based on their credit history from M-PESA

with no interest rate but with a once off loan facilitation fee of 7.5%. In addition, there is free movement of money from M-PESA to M-Shwari with no trip to the bank (Safaricom, 2014).

This continuous growth in mobile money technology needs to be investigated to ensure monetary policy is not compromised by the fast evolving innovation. The most obvious potential effect on monetary policy seems to be related to the velocity of money and money demand. In order for the monetary transmission mechanism to be efficient, the velocity of money should be stable. This can be determined through testing the stability between money, output and prices (Bahmani-Oskooee and Gelan, 2009). However, with growth in mobile money, monetary policy could be affected through the instability of the money demand. Mobile money is comprised of both electronic money and cash that is fully backed up by commercial banks as deposits (Weil et al., 2012; Jack and Suri, 2011). Thus, mobile money by both banked and unbanked is captured in the banking system. While money supply (M1) that comprises of cash outside banks and demand deposits remains unchanged as individuals exchange e-money for cash and vice versa, the velocity of money is likely to change. According to the CBK (2014) monetary policy statement, it has become more difficult to predict money demand due to unstable money multiplier and velocity. All this can be attributed to recent financial innovations such as the mobile money platforms. Although mobile money does not appear to have a direct influence on the money supply so far, Jack and Suri (2011) argue that M-PESA could potentially increase money supply, especially as e-float becomes more widely acceptable as an easily transferrable store of value.

3.4 Data, Model Specification and Estimation

3.4.1. Data

To investigate the relationship between mobile money – the Kenyan financial innovation - and money demand, quarterly data for the period 2000:Q1 to 2014:Q2 was used. Although the operating targets of the CBK for monetary policy are Net Domestic Assets(NDA) and Net International Reserves (NIR), the Central Bank also closely monitors M3 (CBK,2014b). So, as real M3 plays a crucial role in monetary policy, it is considered as our measure for money demand.[30] To generate the real money variable, M3 is divided by the consumer price index. M3 consists of M2 and foreign currency deposits, according to the CBK (2014a) Depository

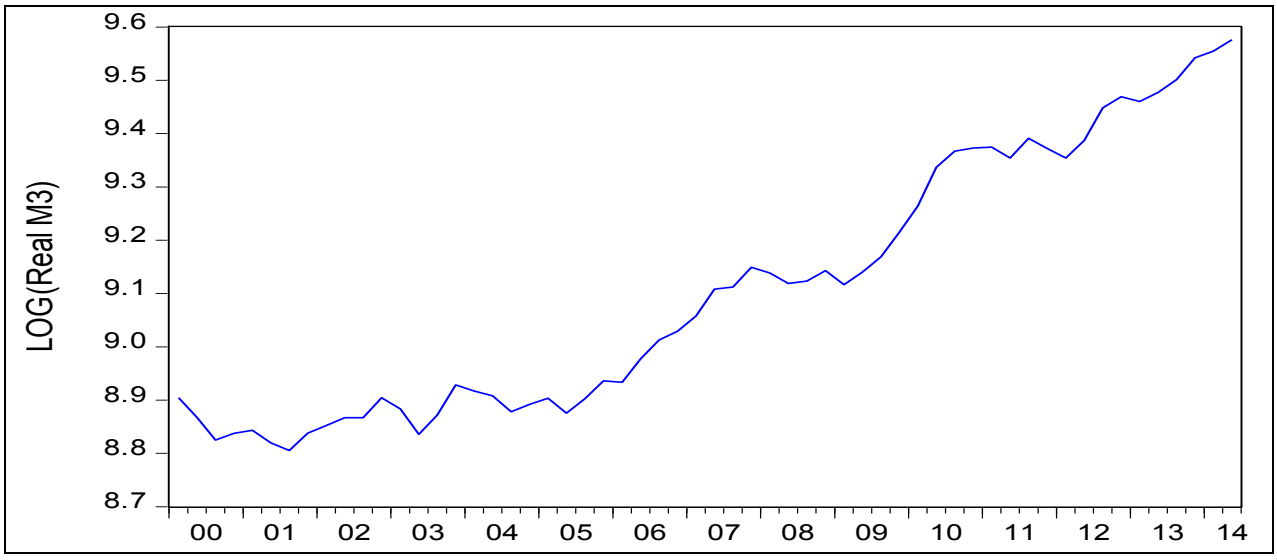
[30] The last month of each quarter is considered because money is a stock.

Corporation Survey[31]. As depicted in Figure 5, the real money demand has been increasing overtime with the largest increase seen after 2008 which also coincides with the period of mobile money usage.

For CPI, exchange rate (RER), and the 91-Treasury bill rate (TBILL) monthly averages were taken to generate quarterly data. Kenya recently (i.e. in 2014) rebased their GDP quarterly figures using 2009 as the base year (instead of 2001) and the new series are available from 2009 to 2014 (KNBS, 2014). Therefore, the pre-2009 GDP series were rebased and a chained index was formed in order to have a consistent data series from 2000–2014 based on 2009 weights.

The real exchange rate was generated by multiplying the ratio of (foreign price/domestic price) by the nominal exchange rate (KES/USD). Thus, an increase would imply a depreciation of the Kenya Shilling, while an appreciation would occur if the exchange rate decreases. The foreign price used was the US consumer price index from the International Financial Statistics (IFS, 2014) since most foreign transactions in Kenya are done in US dollars. The Kenyan consumer price index was used to capture the domestic price.

Figure 5: Real Money (RM3)



Source: Central Bank of Kenya (2014a) for M3 and KNBS (2014a) for CPI. Real M3= M3/CPI

[31] M2 comprises of M1, quasi-money in Banks and Non-Bank Financial Institutions (NBFIs), while M1 consists of currency in circulation, other deposits at CBK and demand deposits in banks (CBK, 2014a)

Using the appropriate measure for mobile money is vital in depicting the true effect of this innovation on money demand. As a result, three measures were considered. Since mobile money was only introduced in 2007, the data limitation prompted the use of these three measures to ensure a longer time frame is captured to get the correct effect of mobile money. The first measure, MOB_M1 takes on a value of zero for the period before the introduction of mobile money (2000:q1-2006:q4), and the ratio of the value of mobile money transactions to M1 for the period after the introduction of mobile money (2007:q1-2014:q2). The monthly mobile money transactions were summed up to get quarterly mobile money transactions. The second measure, MOB_GDP, is also a continuous variable that takes on a value of zero for the period before the introduction of mobile money (2000:q1-2006:q4), and the ratio of the value of mobile money transactions to GDP post mobile money period (2007:q1-2014:q2). A third measure, a dummy variable (MOB_DUM) that takes on a value of 0 prior to mobile money (2000:q1-2006:q4) and 1 post mobile money (2007:q1-2014:q2) was used for robustness checks with the use of real liquid assets (M1). Mobile money transactions, monetary aggregates, Treasury bill rate, and the real exchange rate were acquired from the Central Bank of Kenya (2014a), while the real GDP and CPI were retrieved from the Kenya National Bureau of Statistics (2014). Details of the variable description with the variable name, abbreviation and variable source can be found in Appendix B, Table B1.

Table 7: Summary Statistics

	Mean	Max	Min	Skewness	Kurtosis	Observations
Log(M3/CPI)	9.11	9.58	8.81	0.46	1.78	58
Log(GDP)	13.41	13.80	13.07	0.17	1.86	58
TBILL Rate	8.01	19.35	1.18	0.43	3.88	58
Mobile Money(MOB_M1)	0.19	0.64	0	0.79	1.95	58
Mobile Money(MOB_GDP)	0.14	0.60	0	1.05	2.58	58
Mobile Money(MOB_DUM)	0.5	1.0	0	0.00	1.00	58
Log(Real Exchange rate)	4.47	4.81	4.15	0.28	1.62	58

The evolution of all the variables used in this study is essential in deciding whether to add a trend and or constant for the stationarity tests. The summary statistics in Table 7 indicate that 58 observations were used in this analysis. All the variables used in this study were logged in order to determine their elasticities except the 91-day TBILL rate (TBILL) and mobile money. The next two sections provide the model specification, the estimation method and the empirical findings.

3.4.2. Model Specification and Estimation Method

Based on the quantity theory of money, a traditional money demand equation (see Bahmani-Oskooee and Bohl, 2000; Hamori, 2008) augmented by the real exchange rate and by the variable of interest, mobile money, as depicted in equation 4 below is employed.

$$ln(RM3)_t = \beta_0 + \beta_1 ln(GDP)_t + \beta_2 TBILL_t + \beta_3 MOB_t + \beta_4 ln(RER)_t + \varepsilon_t \quad (4)$$

where:
RM3 (real money) is M3/CPI;
GDP (income) is GDP at constant 2009 prices;
TBILL is the 91- Treasury bill rate;
RER (real exchange rate) is the nominal exchange rate *[US CPI/Kenya CPI]
MOB is mobile money (i.e. MOB_M1, the ratio of the value of mobile money transactions/M1 and takes on a value of zero prior to the introduction of mobile money, or MOB_GDP the ratio of the value of mobile money transactions/GDP and takes on a value of zero prior to the introduction of mobile money)

Financial innovation can be negatively or positively related to money demand based on the type of innovation captured with some studies, such as Arrau et al. (1995), Lippi and Secchi (2009) and Attanasio et al. (2002), finding a negative relationship, while others, such as Hye (2009) and Mannah-Blankson and Belyne (2004), indicating a positive relationship. Mobile money, the coefficient of interest $\beta_{3,}$ could either be positive or negative depending on which effect is greater. While the coefficient on income β_1 is expected to be positive, the Treasury bill rate coefficient β_2 is expected to be negative as money demand theory predicts. However, the exchange rate coefficient β_4 is ambiguous. It could either be positive or negative depending on

whether wealth effects (Dobson and Ramlogan, 2001) or substitution effects (Sriram 2000) are greater.

The Pesaran et al. (2001) autoregressive distributed Lag (ARDL) bounds approach is used in this estimation procedure. The ARDL model by Pesaran et al. (2001) has an advantage over the Johansen and Juselius rank test in that it is more flexible in terms of the order of integration. Testing for stationarity is not necessary for the ARDL method since both I (0) and I (1) variables can be used rather than focus on say I (1) variables. The ARDL method to cointegration may not be satisfactory in determining stability, therefore, applying stability tests such as the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares recursive residuals (CUSUMSQ) tests after cointegration could help determine the stability of the coefficients (Bahmani-Oskooee and Gelan, 2009). This is partly due to the fact that estimated elasticities could remain unstable after cointegration of the variables. Studies that have employed the ARDL approach to cointegration for Kenya but without considering the impact of mobile money include Bahmani-Oskooee and Gelan (2009), Kiptui (2014) and Ndirangu and Nyamongo (2015).

Equation 4 can be re-written as an ARDL model depicted below in equation (5).

$$\begin{aligned}\Delta ln(RM3)_t = {} & a_0 + \sum_{i=1}^{k1} \alpha_i \Delta ln(RM3)_{t-i} + \sum_{i=0}^{k2} \beta_i \Delta ln(GDP)_{t-i} + \sum_{i=0}^{k3} \theta_i \Delta TBILL_{t-i} \\ & + \sum_{i=0}^{k4} \phi_i \Delta MOB_{t-i} + \sum_{i=0}^{k5} \omega_i \Delta RER_{t-i} + \delta_1 ln(RM3)_{t-1} + \delta_2 ln(GDP)_{t-1} \\ & + \delta_3 TBILL_{t-1} + \delta_4 MOB_{t-1} + \delta_5 RER_{t-1} \\ & + \mu_t \end{aligned} \quad (5)$$

The Δ represents first differences while the μ_t is the error term. The bounds test used to determine the presence of cointegration among the variables is based on an F-statistic test (Pesaran et al., 2001). The null hypothesis of no cointegration regardless of whether the regressors are I (1) or I(0) against the alternative hypothesis is as follows:

$H_O: \delta_1 = \delta_2 = \delta_3 = \delta_4 = \delta_5 = 0$

H_A: at least one of $\delta_1, \delta_2, \delta_3, \delta_4, \delta_5 \neq 0$

Cointegration exists if the null hypothesis is rejected. In other words, if the F-statistic is greater than the upper bound I(1) critical value. However if the null is not rejected, i.e. F-statistic is

smaller than the critical values of the lower bound I(0), then cointegration does not exist. However, if the F-test is between the I(0) and I(1) critical values, then the result is inconclusive (Pesaran et al., 2001). If cointegration is established, then long run results and short run results can be generated. The short run results include the error correction term that shows how much disequilibrium is eliminated in each short run period. For cointegration to exist, the error correction term is expected to be negative and significant.

3.5 Results

Although stationarity tests are not necessary per se for the ARDL method, an Augmented Dickey Fuller (ADF) test and a Phillips-Perron test were carried out. This was done to ascertain the order of integration of the variables, since Pesaran et al. (2001) ARDL tests display only I (0) or I (1) critical values. These tests are performed with and without trend (see Tables 8 and 9) and show that some of the variables are I(1) while others are I(0). In some cases, it is difficult to identify with full certainty if a variable is strictly I(0) or I(1), or mutually integrated because it depends on the type of test used and whether or not a trend was added. All the variables in levels seem to indicate a trend is necessary except for the Tbill rate (see Appendix B, Figure B10).The only variables that are strictly I(1) include (RM3), the real exchange rate and mobile money (MOB_M1). However MOB_GDP is only I(1) when the Phillips Peron test is used, probably because of the structural break of mobile money. The Phillips Peron unit root test is able to test for unit roots in the presence of structural breaks (Enders, 2010). The rest of the variables are either I(0) or I(1). Therefore, some other methods used for cointegration such as Johansen Juselius and Engel and Granger may not be easily implemented without certainty of the order of integration. But since the order of integration does not matter for the ARDL per se, i.e. regardless of whether the variable is I (0) or I (1), ARDL is the most appropriate method for this analysis.

Table 8: Stationarity Tests (without Trend)

	ADF Test		Phillips-Perron Test		
Variables	levels	1st Difference	levels	1st Difference	Result
Log(RM3)	1.45	-6.04***	1.45	-6.03***	I(1)
Log(GDP)	0.72	-3.84***	0.81	-13.77***	I(1)
TBILL Rate	-3.26**	-5.31***	-2.70*	-5.17***	I(0)
Log(Real Exchange Rate)	-0.71	-7.04***	-0.56	-8.19***	I(1)
Mobile Money(MOB_M1)	0.37	-3.48**	0.93	-3.47**	I(1)
Mobile Money(MOB_GDP)	-1.34	-1.30	2.54	-6.22***	>I(1) or I(1)

*p-value<0.10, **p-value<0.05, ***p-value<0.01

Table 9: Stationarity Tests (with Trend)

	ADF Test		Phillips-Perron Test		
Variables	levels	1st Difference	levels	1st Difference	Result
Log(RM3)	-2.92	-6.31***	-2.92	-6.24***	I(1)
Log(GDP)	-3.39*	-3.96**	-5.91***	-14.80***	I(0)
TBILL Rate	-3.23*	-5.25***	-2.89	-5.09***	I(0) or I(1)
Log(Real Exchange Rate)	-2.44	-6.97***	-2.38	-8.15***	I(1)
Mobile Money	-1.75	-3.77**	-1.54	-3.76**	I(1)
Mobile Money (MOB_GDP)	-2.23	-2.50	-0.20	-9.25***	>I(1) or I(1)

*p-value<0.10, **p-value<0.05, ***p-value<0.01

Once the order of intergration was confirmed, the ARDL bounds test for cointegration was employed. As depicted in Table 10, there is no evidence of cointegration at a 5 percent level of significance with the exclusion of mobile money (model 0). In other words, the F-statistic is 3.62 and lies between the upper bound I(1) and lower bound I(0) critical values implying the test is inconclusive for model 0 at a 5 percent level of significance. However, once mobile money is included in the equation, all the models show evidence of a stable money demand at a 5 percent level of significance, except for model 3 (with MOB_M1 and trend) and model 5 (with MOB_GDP and RER) that only depicted a stable money demand at a 10 percent level.

Table 10: ARDL Bounds Test for Cointegration-Full Sample (All Models)

			10%		5%		
	Model	F-Statistic	I(0)	I(1)	I(0)	I(1)	Cointegration
0.	F((M3/CPI)| GDP, TBILL, RER)[4]	3.62	2.37	3.20	2.79	3.67	Inconclusive 5%
1.	F((M3/CPI)|GDP, TBILL, MOB_M1)[4]	4.08	2.37	3.20	2.79	3.67	Yes
2.	F((M3/CPI)|GDP, TBILL, MOB_M1, RER)[4]	3.86	2.20	3.09	2.56	3.49	Yes
3.	F((M3/CPI)|GDP, TBILL, MOB_M1, TREND)[4]	3.94	2.68	3.53	3.05	3.97	Inconclusive 5%
4.	F((M3/CPI)|GDP, TBILL, MOB_GDP)[4]	3.82	2.37	3.20	2.79	3.67	Yes
5.	F((M3/CPI)|GDP, TBILL, MOB_GDP RER)[4]	3.10	2.20	3.09	2.56	3.49	Inconclusive 5%
6.	F((M1/CPI)|GDP, TBILL, MOB_DUM)[4]	7.97	2.37	3.20	2.79	3.67	Yes
7.	F((M1/CPI)|GDP, TBILL, MOB_DUM, RER)[4]	7.62	2.20	3.09	2.56	3.49	Yes

[.] represents the number of lags used based on the Schwarz Criteria (SC) test for optimal lag length determination. Cointegration exists if the null hypothesis is rejected. In other words, if the F-statistic is greater than the upper bound I(1) critical value. However if the null is not rejected, i.e. F-statistic is smaller than the critical values of the lower bound I(0), then cointegration does not exist. However, if the F-test is between the I(0) and I(1) critical values then the result is inconclusive (Pesaran et al., 2001)

The first set of results in Tables 11 and 12 consider MOB_M1 as the measure of mobile money. Similarly, Tables 13 and 14 use MOB_M1 as a measure of mobile money with an addition of a time trend. MOB_GDP is the alternative measure employed in the third set of results depicted in Tables 15 and 16. And, finally, in Tables 17 and 18, MOB_DUM is considered as another alternative measure of mobile money. For sensitivity of the results, the money demand equation is initially estimated without the real exchange rate as depicted in model (1).

In Tables 11 and 12, models (1) and (2) are estimated without the real exchange rate and with the inclusion of the exchange rate respectively. The optimal lag length structure for the ARDL was determined based on the smallest Schwarz Criteria as indicated in Figure B1 Appendix B prior to the test for cointegration. The ARDL(1,0,2,0) was found to be the most appropriate for model (1) while ARDL (1,0,0,0,3) the best option for model (2). The ARDL bounds test to cointegration results indicate that there is evidence at the 5% level of significance of a long run relationship between money demand and its regressors with an F-Statistic of 4.08 for model (1) and 3.86 for model (2).

Table 11: Long-run Coefficient estimates with MOB_M1[32]

Long-run estimates from an ARDL (1,0,2,0)	
RM3 = -4.05 + 0.98 GDP -0.004 TBILL + 0.30 MOB_M1	(1)
(2.40)* (0.18)*** (0.004) (0.13)**	
Long-run estimates from an ARDL (1,0,0,0,3)	
RM3 = -0.38 + 0.75 GDP -0.01 TBILL + 0.40 MOB_M1 – 0.12RER	(2)
(6.12) (0.38)* (0.005) (0.16)** (0.25)	

*Dependent variable: Real M3. RM3, GDP and RER are entered in the money demand equation as logarithmic transformations.*p-value<0.10, **p-value<0.05, ***p-value<0.01. (.) represent the standard errors, [.] represents the number of lags used based on the Schwarz Criteria(SBC) for optimal lag length determination.*

Table 12: Short-run Coefficient estimates using ARDL with MOB_M1

	(1)	(2)
Δ GDP	0.25(0.07)***	0.2(0.06)***
Δ TBILL rate	-0.002(0.002)	-0.003(0.002)*
Δ TBILL rate[-1]	-0.005(0.002)***	-----
Δ Mobile Money (MOB_M1)	0.13(0.17)	0.05(0.16)
Δ Real Exchange rate	-----	0.21(0.07)***
Δ Real Exchange rate[-1]	-----	0.01(0.08)
Δ Real Exchange rate[-2]	-----	-0.24(0.08)***
ecm[-1]	-0.26(0.06)***	-0.19(0.05)***
Diagnostic Tests		
Breusch-Godfrey Serial Correlation LM Test:	1.21	2.14
R-Squared	0.20	0.44
Ramsey's RESET	0.84	0.23
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.16	0.85
CUSUM	stable	stable
CUSUM SQ	stable	stable

*Dependent variable: Real M3. RM3, GDP and RER are entered in the money demand equation as logarithmic transformations.*p-value<0.10, **p-value<0.05, ***p-value<0.01. (.)represents the standard errors, [.] represents the number of lags used based on the Schwarz Criteria(SBC) for optimal lag length determination.*

The results for models (1) and (2) indicate that the coefficient on GDP is positive and significant in both the long run and short run. This is consistent with the quantity theory of money demand a priory predictions. The coefficient on income in the long run is close to 1 in both models. These results are somewhat different from some empirical studies in Kenya that find the coefficient to

[32] The results with exclusion of financial innovation were excluded from the analysis because the cointegration results were inconclusive as depicted in Table 10, with only GDP significant while inflation and the exchange rates were both insignificant.

be greater than 1 (see Darrat, 1985; Adam, 1992; Sichei and Kamau, 2012; Ndirangu and Nyamongo, 2015) while others such as Mwega (1990) find income elasticity to be lower than 1. However, the TBILL that has the correct sign appears to be significant only in the short run. This result is similar to Ndirangu and Nyamongo (2015) who find interest rates to affect money demand only with the use of M1 and M2 as measures for real money. With the M3 measure, however, interest rates appear to be significant only in the short run.

Similarly, the real exchange rate does not seem to have an impact on money demand in the long run, but it appears to have an overall negative effect on money demand in the short run. This could imply that for the case of Kenya, substitution effect is more evident than the wealth effect. Put differently, a depreciation of the exchange rate is likely to lead to higher demand for foreign bonds. This substitution of domestic money for foreign bonds leads to a decline in the demand for money. Although the results differ from Ndirangu and Nyamongo (2015) who find evidence for wealth effects, other studies such as Kiptui (2014) and Bahmani-Oskooee and Gelan (2009) find strong evidence of the substitution effect for the case of Kenya.

The coefficient on mobile money, the variable of interest is positive and significant at a 5 percent level for both models in the long run. This suggests that mobile money is an important variable in modelling money demand. Failure to account for it might lead to a misspecified money demand equation that could potentially have implications for monetary policy. These results are different from other studies on financial innovation in Kenya that use other measures, such as Ndirangu and Nyamongo (2015) who find a negative relationship between financial innovation and money demand using currency outside banks/time deposit ratio as a proxy for financial development, and Sichei and Kamau (2012) who find a negative relationship using number of ATMs.

One possible explanation for the positive relationship between mobile money and money demand is due to the fact that mobile money is backed up in commercial banks as deposits. With other measures of financial innovation, individuals tend to move away from more liquid assets (M1) to less liquid assets (M2 or M3) and, as a result, the demand for money is reduced. However, mobile money is an alternative form of cash (i.e. e-money) and not necessarily an alternative form of asset other than cash. Initially, as mobile money usage increases, so does the demand for money. Individuals who would otherwise not have had access to financial services

probably due to lack of access to a bank (for example, individuals who used to keep money under their mattresses or those who were involved in barter trade prior to the introduction of mobile money), can now do so with easier access using an alternative form of cash. For the case of Kenya, the positive effect appears to be much stronger than the negative effect of mobile money on money demand.

The results also indicate that the error correction terms for models (1) and (2) are negative and highly significant justifying the existence of cointegration. The error correction term measures the speed of adjustment to equilibrium and in model (1), 26 percent of the disequilibrium is eliminated in each short run period, while 19 percent is eliminated in model (2). In other words, the speed of adjustment to equilibrium for model (1) is faster and takes 3.8 quarters to return to equilibrium while model (2) takes a little over 5 quarters. Both models seem to perform well according to the diagnostic tests. The Ramsey test suggests that the models are well defined, while the Breusch-Godfrey serial correlation test and the Breusch-Pagan Godfrey test indicate that there is no serial correlation or heteroscedasticity, respectively. To check for the stability of the coefficients for both models, the CUSUM and CUSUMSQ tests were employed, as depicted in Appendix B, Figures B4 and B5 for models (1) and (2), respectively. The stability tests indicate that the coefficients for both models are stable with the CUSUM and CUSUMSQ tests within the 5% confidence bands.

The second set of results test for robustness with inclusion of a time trend in Tables 13 and 14 to ensure that the positive effect of mobile money on money demand depicted in Table 11, is not necessarily due to other factors not captured in the regression. There was evidence of cointegration with inclusion of a time trend only at a 10 percent level of significance with an F-test of 3.94 (see Table 10). As depicted in Table 13, the ARDL (2,3,0,0) is the most appropriate model. The results in Tables 13 and 14 indicate that mobile money remains highly significant in both the long run and the short run, a result similar to model (1) in Table 11. As expected, GDP is positively related to money demand, while the interest rate has a negative effect in the long run and the trend is highly significant as well. These results are similar to the previous results in Tables 11 and 12. This indicates that mobile money is indeed an important variable in determining money demand, and suggests that it could be partly responsible for the increase in money demand for the post 2007 period after its introduction.

Table 13: Long-run Coefficient estimates with a Trend

Long-run estimates from an ARDL (2,3,0,0)	
RM3 = -15.60 + 1.87 GDP -0.01 TBILL + 0.33 MOB_M1 - 0.01 TREND	(3)
(5.07)*** (0.39)*** (0.002)*** (0.68)*** (0.005)**	

*Dependent variable: Real M3. RM3 and GDP are entered in the money demand equation as logarithmic transformations.*p-value<0.10, **p-value<0.05, ***p-value<0.01. (.) represent the standard errors, [.] represents the number of lags used based on the Schwarz Criteria(SBC) for optimal lag length determination.*

Table 14: Short-run Coefficient estimates using ARDL with a Trend

	(3)
Δ RM3	0.32(0.14)**
Δ GDP	0.18(0.13)
Δ GDP[-1]	-0.53(0.15)***
Δ GDP[-2]	-0.38(0.13)***
Δ TBILL rate	-0.005(0.001)***
Δ Mobile Money (MOB_M1)	0.17(0.05))***
Trend	-0.006(0.003)**
Constant	-7.80(3.01)**
ecm[-1]	-050(0.11))***
Diagnostic Tests	
Breusch-Godfrey Serial Correlation LM Test:	1.47
R-Squared	0.42
Ramsey's RESET	0.44
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.004
CUSUM	stable
CUSUM SQ	stable

*Dependent variable: Real M3. RM3 and GDP are entered in the money demand equation as logarithmic transformations. p-value<0.10, **p-value<0.05, ***p-value<0.01. (.) represent the standard errors, [.] represents the number of lags.*

The next set of results depicted in Tables 15 and 16 use an alternative measure of mobile money, MOB_GDP. The ARDL(1,0,2,0) is the most appropriate for model (4), while ARDL (3,2,0,1,4) is the best option for model (5), according to the Schwarz Criteria depicted in Figure B2, Appendix B. Similar to the previous models, there is evidence of cointegration for model (4) at a 5 percent (F-statistic 3.82) but cointegration is only present for model (5) at a 10 percent level (F-statistic 3.10) of significance (see Table 10 for cointegration results). Although the results in model (4) Table 15 with exclusion of the exchange rate, are generally similar to the results with the MOB_M1 measure in model (1) Table 11, the results with inclusion of the exchange rate in model (5), Table 15 are not as robust as in model (2), Table 11 in the long run, even with all

variables significant in the short run (see Table 16). Nevertheless, the findings indicate that mobile money is highly significant and positively related to the demand for money in both the short run and long run, with the coefficients in the long run similar to Table 11 results that considered the MOB_M1 measure.

Table 15: Long-run Coefficient estimates with MOB_GDP

Long-run estimates from an ARDL (1,0,2,0)

RM3 = -4.46 + 1.01 GDP -0.003 TBILL + 0.34 MOB_GDP (4)
(2.25)* (0.17)*** (0.004) (0.15)**

Long-run estimates from an ARDL (3,2,0,1,4)

RM3 = -1.37 + 0.61 GDP -0.001 TBILL + 0.43 MOB_GDP – 0.10RER (5)
(5.97) (0.37) (0.003) (0.15)*** (0.23)

*Dependent variable: Real M3. RM3, GDP and RER are entered in the money demand equation as logarithmic transformations.*p-value<0.10, **p-value<0.05, ***p-value<0.01. (.) represent the standard errors, [.] represents the number of lags used based on the Schwarz Criteria(SBC) for optimal lag length determination.*

Table 16: Short-run Coefficient estimates using ARDL with MOB_GDP

	(4)	(5)
Δ RM3[-1]	-----	0.37(0.12)***
Δ RM3[-2]	-----	0.41(0.11)***
Δ GDP	0.29(0.07)***	0.37(0.07)***
Δ GDP[-1]	-----	-0.15(0.06)***
Δ TBILL rate	-0.003(0.002)	-0.002(0.001)
Δ TBILL rate[-1]	-0.004(0.002)**	-----
Δ Mobile money(MOB_GDP)	0.38(0.15)**	0.65(0.12)***
Δ Real Exchange rate	-----	0.23(0.07)***
Δ Real Exchange rate[-1]	-----	-0.06(0.07)
Δ Real Exchange rate[-2]	-----	-0.26(0.07)
Δ Real Exchange rate[-3]	-----	0.23(0.07)***
ecm[-1]	-0.20(0.06)***	-0.33(0.08)***
Diagnostic Tests		
Breusch-Godfrey Serial Correlation LM Test:	1.05	0.62
R-Squared	0.19	0.66
Ramsey's RESET	2.35	0.92
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.3	0.72
CUSUM	stable	stable
CUSUM SQ	stable	stable

*Dependent variable: Real M3. RM3, GDP and RER are entered in the money demand equation as logarithmic transformations.*p-value<0.10, **p-value<0.05, ***p-value<0.01. (.) represent the standard errors, [.] represents the number of lags used based on the Schwarz Criteria(SBC) for optimal lag length determination.*

While GDP is statistically significant and positive as predicted by theory, once the exchange rate is added to model (5), GDP becomes insignificant in the long run. It is however, significant with an overall positive sign in both models in the short run. With respect to interest rates, the results depict that it is insignificant in the long run though significant with the appropriate sign in the short run for model (4) only. The exchange rate is insignificant in the long run, a result that has been depicted in the previous set of results. However, it is positive and highly significant in the short run. This suggests that a depreciation of the exchange rate is likely to lead to an increase in money demand in the short run, which implies that the wealth effect is much greater than the substitution effect in Kenya. With the depreciation of the exchange rate, foreign assets by domestic residents are likely to increase and lead to accumulation of wealth (Dobson and Ramlogan, 2001). These results are contradictory to what was realised in the earlier results in Table 12, where the exchange rate was negatively related to money demand in the short run. This suggests that the sign of the exchange rate appears to be sensitive to the measure of mobile money used, though overall, the MOB_M1 measure performs with better precision as seen in model (2) in comparison to model (5).

The error correction term for both models is also highly significant with a negative coefficient of 20 percent and 33 percent for model (4) and model (5), respectively. This not only confirms the long run relationship between money demand and its determinants, but also indicates that it takes about 5 quarters to return to equilibrium in model (4) and approximately 3 quarters in model (5). This, too, is similar to the speed of adjustment depicted in the previous results in Table 12. As for the diagnostic tests, the Ramsey test indicated that the models were well specified and no heteroscedasticity or serial correlation was found. Additionally, the CUSUM and CUSUMSQ appear to indicate that the residuals all lie within the 5 percent confidence bands. This suggests stability of the money demand in both models (See Appendix B, Figures B6 and B7).

Table 17: Long-run Coefficient estimates with a Dummy Variable[33]

Long-run estimates from an ARDL (1,2,0)

RM1 = -9.49 + 1.33 GDP -0.02 TBILL + 0.1 MOB_DUM (6)
(1.16)*** (0.09)*** (0.002)*** (0.03)***

Long-run estimates from an ARDL (1,2,0,0)

RM1 = -8.44 + 1.27 GDP -0.02 TBILL - 0.06 RER + 0.09 MOB_DUM (7)
(2.51)*** (0.15)*** (0.003)*** (0.13) (0.03)***

*Dependent variable: Real M1.RM1, GDP and RER are entered in the money demand equation as logarithmic transformations.*p-value<0.10, **p-value<0.05, ***p-value<0.01. (.) represent the standard errors, [.] represents the number of lags used based on the Schwarz Criteria(SBC) for optimal lag length determination.*

Table 18: Short-run Coefficient estimates with a Dummy Variable

	(6)	(7)
Δ GDP	0.55(0.10)***	0.55(0.10)***
Δ GDP[-1]	-0.41(0.10)***	-0.38(0.10)***
Δ TBILL rate	-0.01(0.002)***	-0.01(0.002)***
Δ Real Exchange rate	-----	0.08(0.11)
Mobile Money (MOB_DUM)	0.16(0.03)***	0.15(0.03)***
ecm[-1]	-0.55(0.09)***	-0.55(0.09)***
Diagnostic Tests		
Breusch-Godfrey Serial Correlation LM Test:	1.25	4.08
R-Squared	0.38	0.43
Ramsey's RESET	1.88	0.23
Heteroskedasticity Test: Breusch-Pagan-Godfrey	1.49	0.85
CUSUM	unstable	unstable
CUSUM SQ	unstable	unstable

*Dependent variable: Real M1. RM1, GDP and RER are entered in the money demand equation as logarithmic transformations. *p-value<0.10, **p-value<0.05, ***p-value<0.01. (.) represent the standard errors, [.] represents the number of lags used based on the Schwarz Criteria(SBC) for optimal lag length determination.*

For robustness checks of the results, the dummy variable (MOB_DUM) was also considered, but with real M1 as a measure for money demand as shown in Tables 17 and 18 for the long run, and short run results, respectively. Again, the most appropriate lags were chosen based on the Schwarz Criteria depicted in Appendix B, Figure B3. The ARDL (1,2,0) was found to be the

[33] In addition to the dummy variable, broad measures of financial innovation such as M2/M1 were considered but the results indicated that this broad measure was insignificant though negatively related to money demand. This result is similar to studies on Kenya that find no evidence of financial innovation on money demand using broad measures such as Ndirangu and Nyamongo(2015) who used currency outside banks/time deposits and Sichei and Kamau(2012) who used the number of ATMs.

most appropriate for model (6), while ARDL (1,2,0,0) the best option for model (2). The results indicate evidence of cointegration at a 5 percent level of significance for both models (6) and (7) with an F-Statistic of 7.97 and 7.62 respectively as depicted in Table 10. As earlier predicted by the two alternative measures of mobile money, MOB_DUM was found to be positive and highly significant in both the long run and the short run as shown in Tables 17 and 18. This suggests that periods with mobile money had a positive impact on money demand compared to periods without mobile money.

For the traditional determinants of mobile money, income and interest rates were also found to be highly significant and positively and negatively related to money demand respectively in the long run. This result is different from the previous results for interest rates as it was found to be insignificant in the long run when real M3 was used as a measure for money demand (see Tables 11 and 12. This could suggest that the interest rate appears to have a greater effect on narrow money than broad money in the long run.

Although the exchange rate is insignificant in the long run and the short run, the short run results for all the other variables are significant with the correct signs. The diagnostic tests depict that the models are both well specified with the Ramsey Reset test and that there is no evidence of heteroskedasticy or autocorrelation. While a long run relationship is evident with a highly significant error correction term, the CUSUM and CUSUMSQ test depict evidence of an unstable demand with the use of M1 (See Appendix B, Figure B8 and B9). Nevertheless, what remains clear from all the separate sets of results is that mobile money is highly significant and positively related to money demand. This suggests that its exclusion could lead to a misspecification of the money demand function which could hinder monetary policy.

3.6 Conclusion

The aim of this chapter was to investigate the relationship between mobile money, a particular type of financial innovation, and money demand in Kenya. Using the ARDL approach to cointegration over the period 2000Q1 to 2014Q2, mobile money was found to be an important variable in determining money demand with a positive relationship between mobile money and money demand. This result is robust even with the use of alternative measures of mobile money.

A possible explanation for this positive relationship could be the fact that mobile money is backed up in commercial banks as deposits and because mobile money is an alternative form of cash (i.e. e-money) and not necessarily an alternative form of asset other than cash, there is an incentive to hold onto this new form of cash rather than assets. This is especially true for individuals who would have otherwise not had access to financial services, and kept money under their mattresses or those individuals who were involved in barter trade prior to the introduction of mobile money. As a result, the initial effect of mobile money on money demand was found to be positive.

While income was found to be significant and positively related to money demand, as predicted by the quantity theory of money, the interest rate was only significant and negatively related to money demand in the short run when the real broad money measure was considered. However, once narrow money was used, the interest rate was negative and significant as expected from theory. This suggests that the interest rate for the case of Kenya appears to be more sensitive to M1 than M3, a result similar to Ndirangu and Nyamongo (2015) who found that interest rates are significant for M1 and M2 but not M3 for Kenya. The exchange rate appears not to have any effect on money demand in the long run, regardless of the measure of mobile money used.

The Kenyan money demand was found to be stable when mobile money was taken into consideration. Evidence of a stable money demand with the inclusion of mobile money has important implications for the effectiveness of monetary policy in Kenya, and possibly in other countries that have seen developments in mobile money in recent years. Failure to account for mobile money in the money demand equation could lead to misspecification of the demand for money and hinder the proper monitoring of prices by the monetary authorities. With the growing trend in mobile money usage and with further improvements in this technology, it may become challenging in the future for the Central Bank to carry out monetary aggregate targeting. Kenya seems to have taken the right steps in beginning to gradually move away from monetary aggregate targeting to a more forward looking policy (IMF, 2015). Other countries that have adopted mobile money technology may also learn from the Kenyan case study especially those that are still targeting monetary aggregates. Mobile money technology is evolving quickly and it may become harder for these countries to also meet their targets. While mobile money technology could complicate monetary policy, it is expected to improve efficiency in the banking

sector and the real economy due to the reduction in transaction costs which could improve people's livelihoods.

Appendix B

Figure B 1: Schwarz Criteria lag selection for model (1) and model (2)

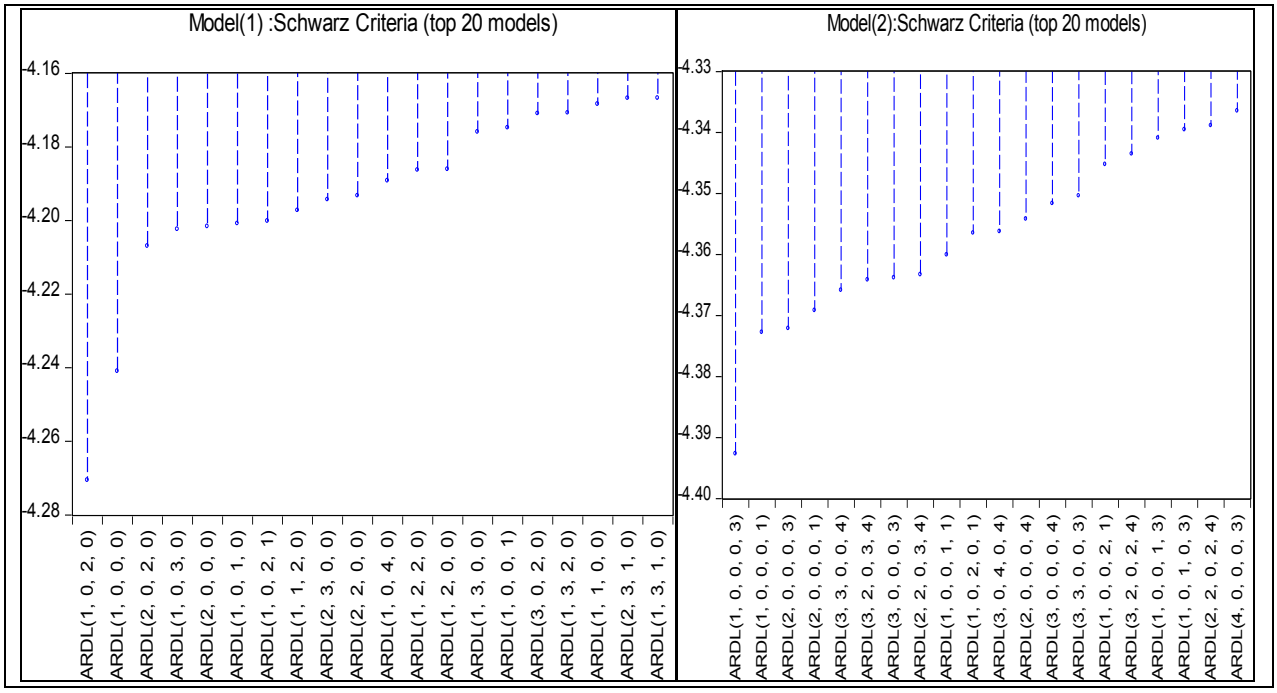


Figure B2: Schwarz Criteria lag selection for model (4) and model (5)

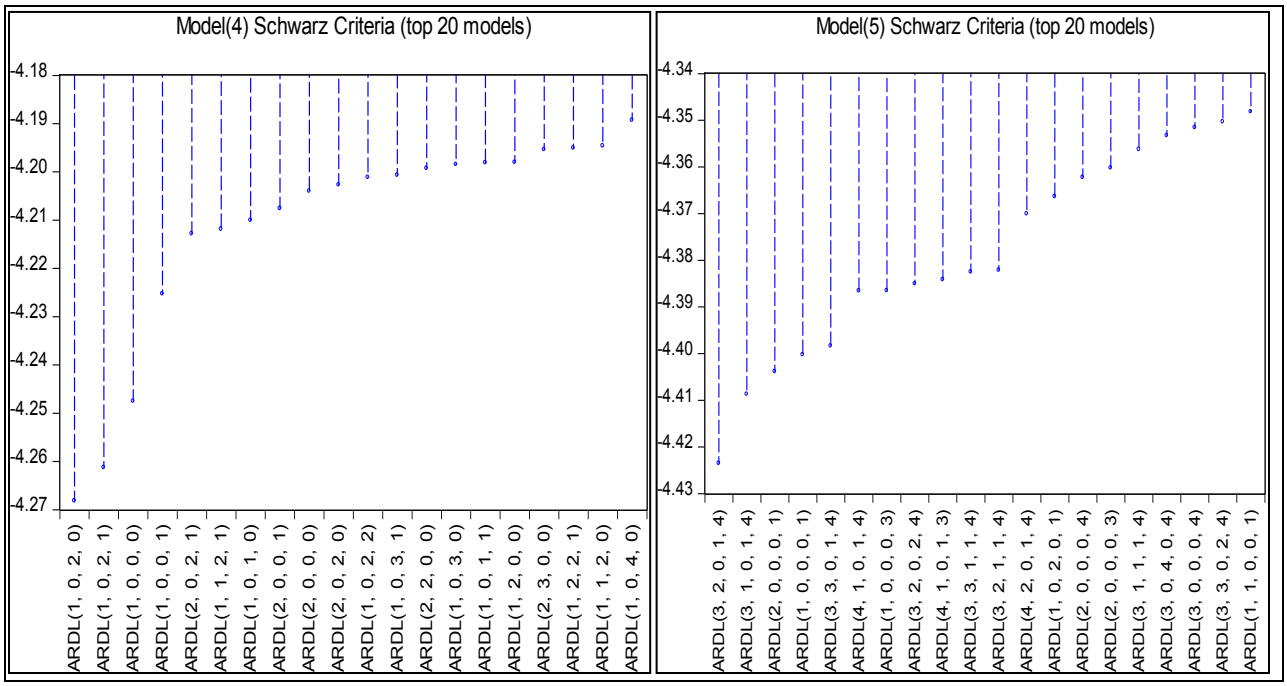


Figure B3: Schwarz Criteria lag selection model (6) and model (7)

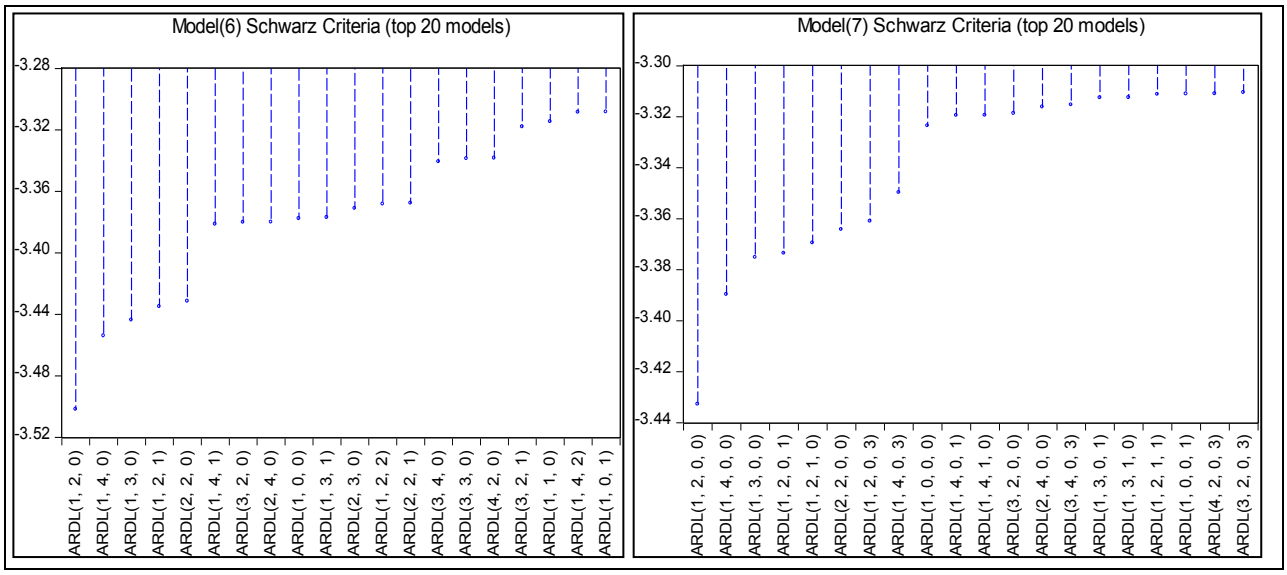


Figure B4: CUSUM and CUSUMSQ (Model 1)

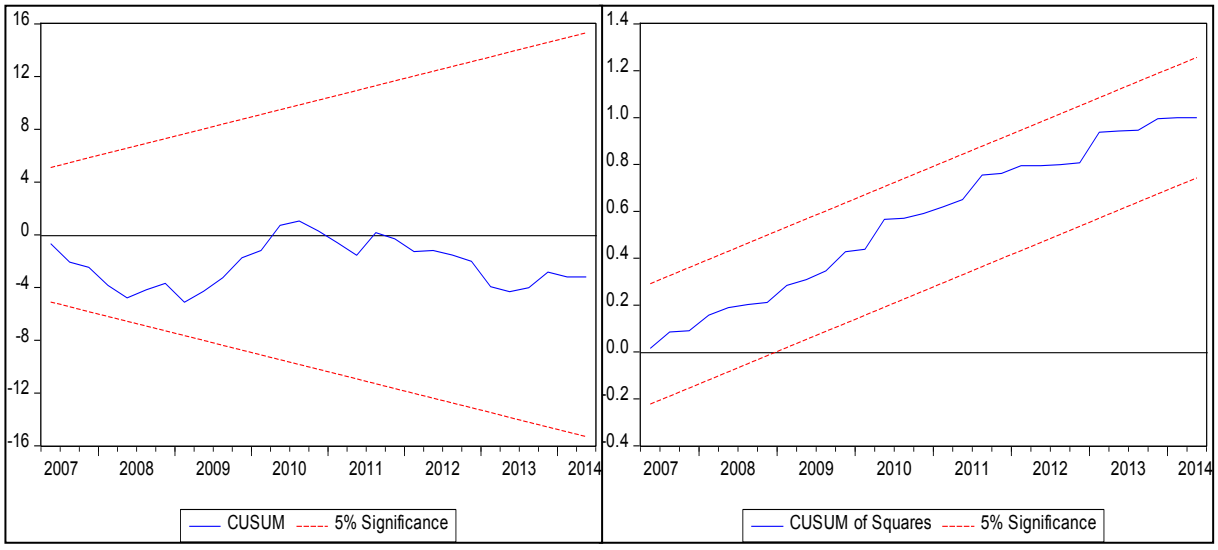


Figure B5: CUSUM and CUSUMSQ (Model 2)

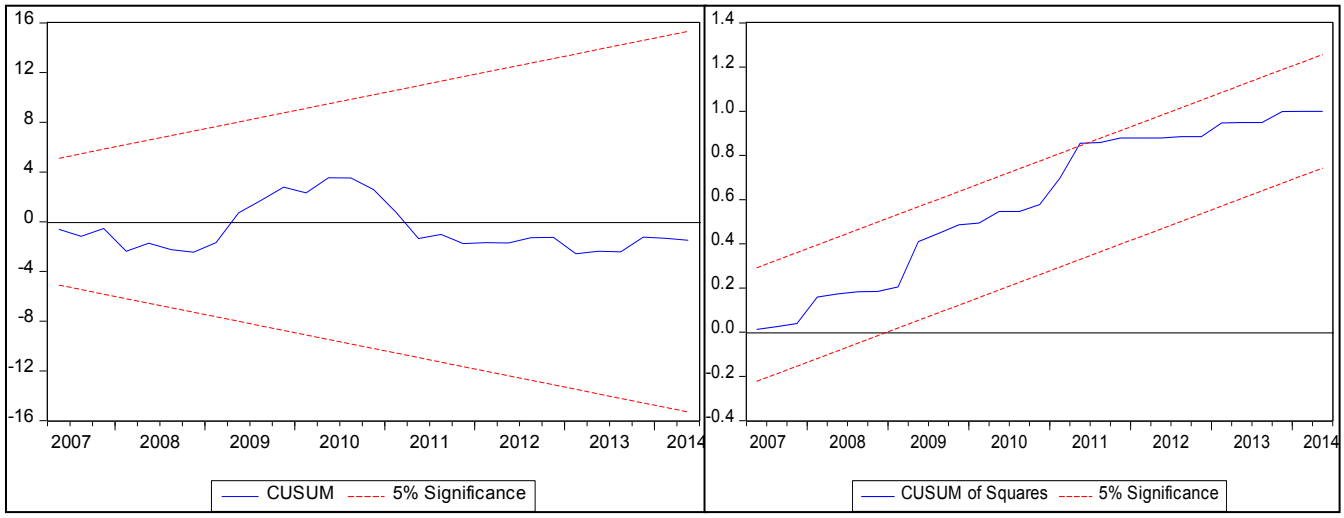


Figure B6: CUSUM and CUSUMSQ (Model 4)

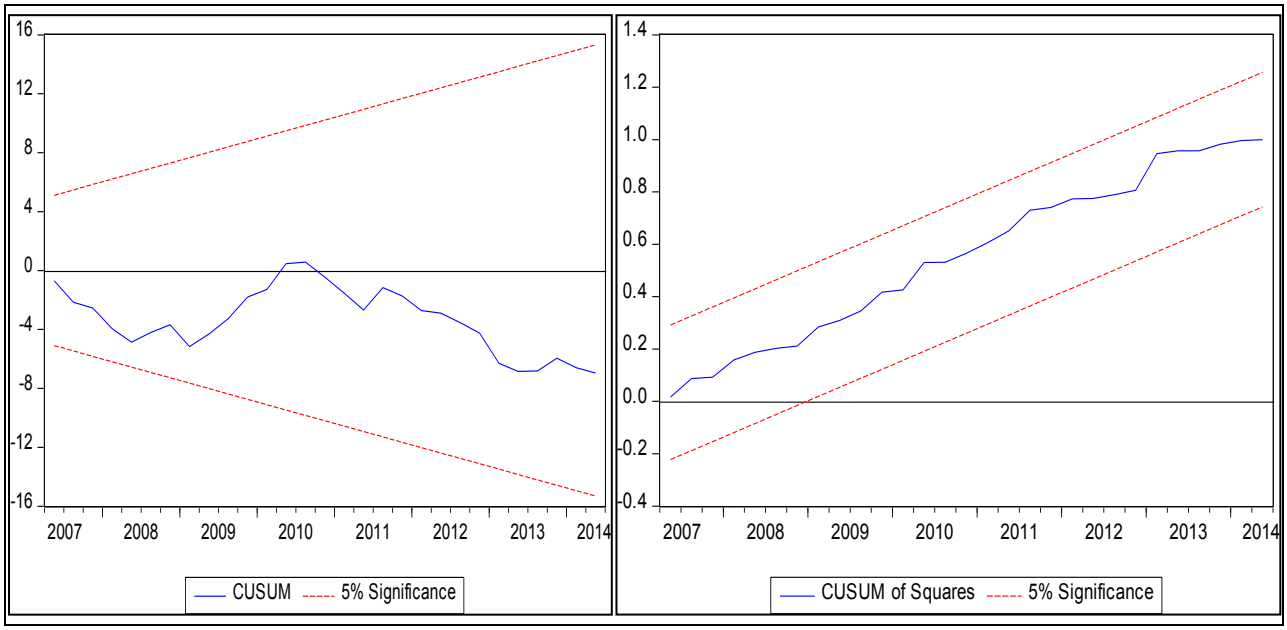


Figure B 7: CUSUM and CUSUMSQ (Model 5)

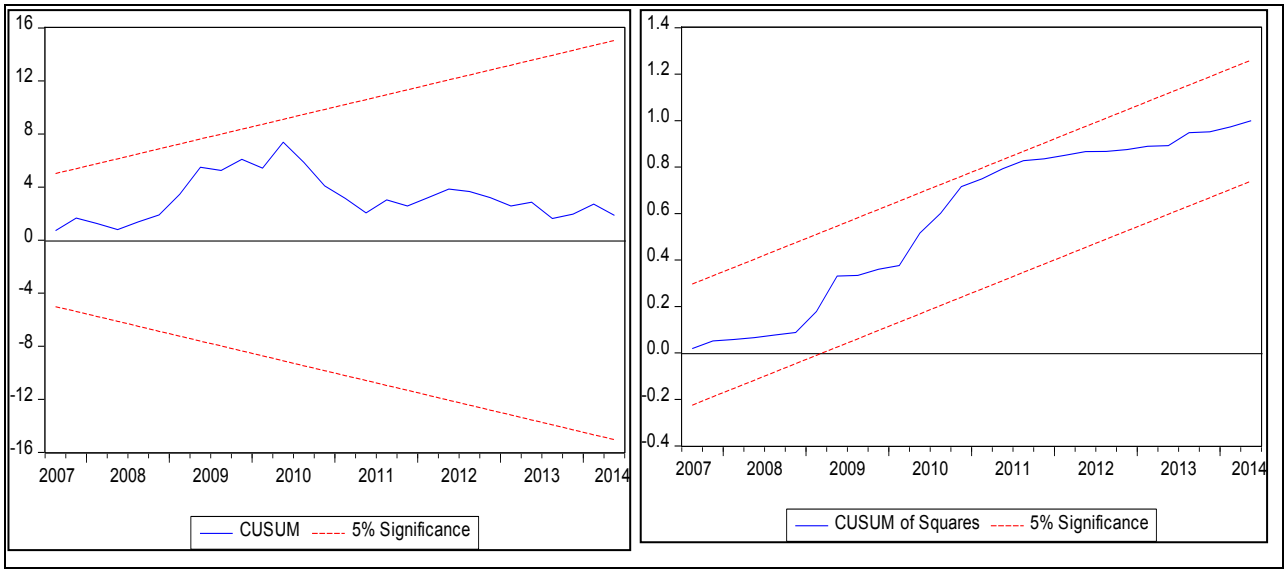


Figure B 8: CUSUM and CUSUMSQ (Model 6)

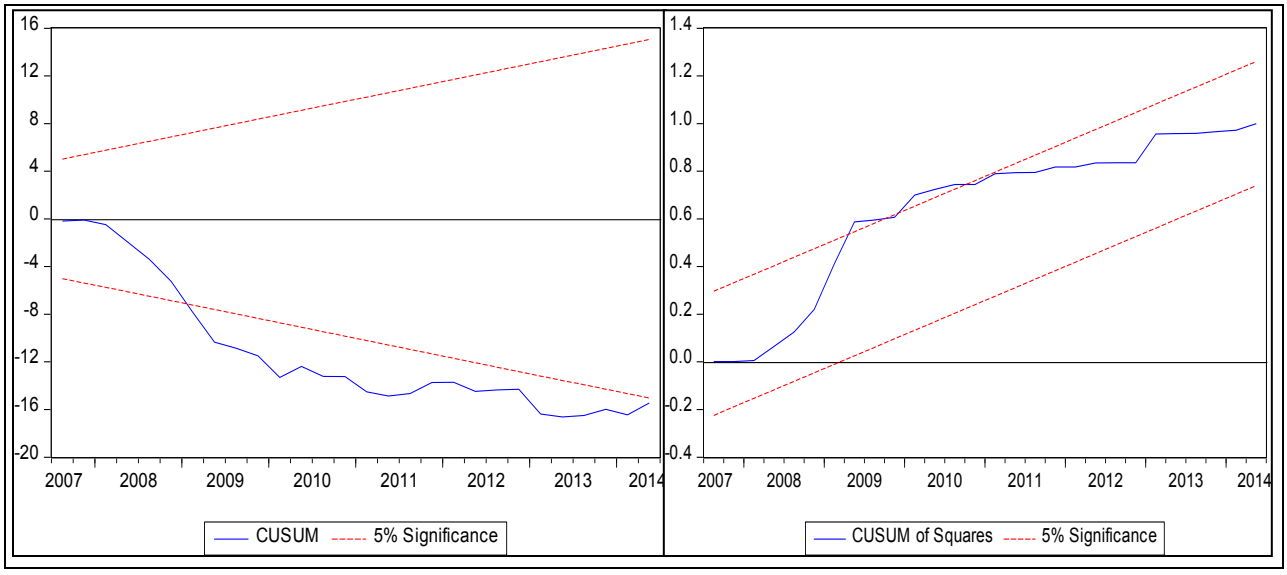


Figure B 9: CUSUM and CUSUMSQ (Model 7)

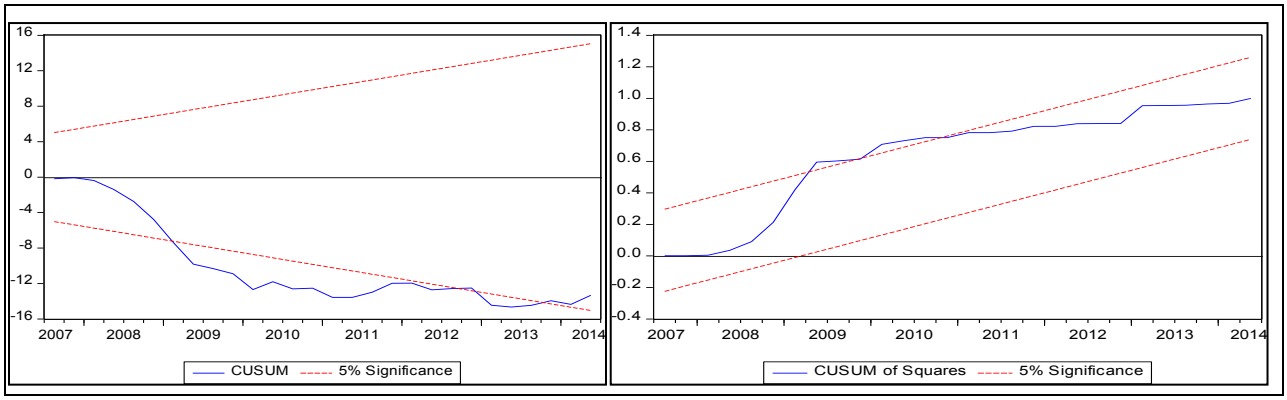


Figure B 10: Variables in Levels

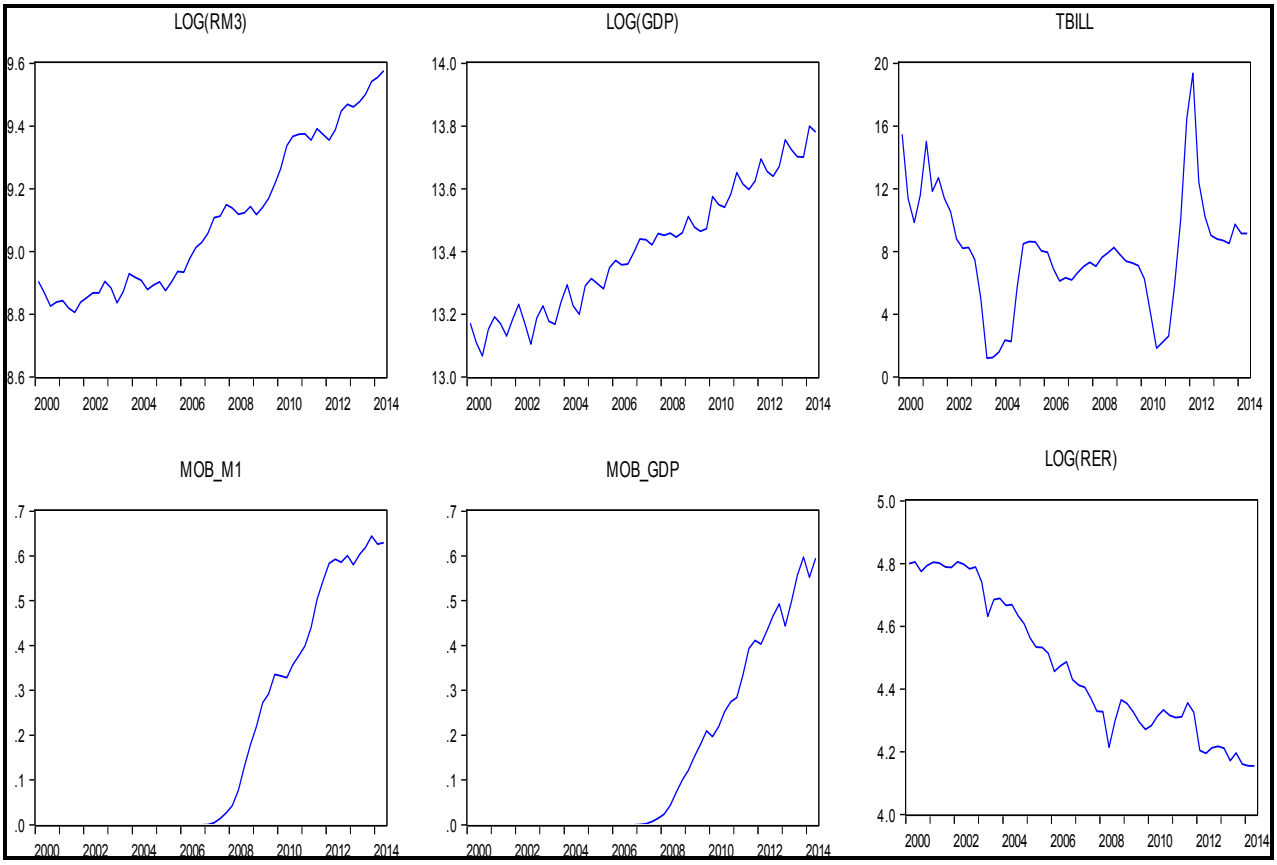


Table B 1: Variable Description

VARIABLE NAME	DESCRIPTION	ABBREVIATION	SOURCE
Money demand (Real M3)	Monetary aggregates in Ksh. Millions divided by CPI (M3/CPI)	RM3	CBK, 2014a and KNBS,2014a for CPI
Real Gross Domestic Product	GDP at constant 2009 prices- Kshs. Millions	GDP	KNBS, 2014a
Treasury Bill Rate	91-Tbill rate	TBILL	CBK, 2014a
Real Exchange rate	Kenya Shilling/ USdollar Nominal Exchange rate (NER) *[US CPI/Kenya CPI)	RER	CBK, 2014a for exchange rate, KNBS,2014a for CPI and IFS, 2014 for US CPI
Mobile money (MOB_M1)	0 for the period before mobile money was introduced(2000q:1-2006:q4) and for the period with mobile money use(2007:q1-2014:4), the ratio of the value of mobile money transactions(in Ksh. Millions)/M1(Ksh. Millions) was taken	MOB_M1	CBK, 2014a
Mobile money (MOB_GDP)	0 for the period before mobile money was introduced(2000q:1-2006:q4) and for the period with mobile money use(2007:q1-2014:4), the ratio of the value of mobile money transactions(in Ksh. Millions)/GDP(Ksh. Millions) was taken	MOB_GDP	CBK, 2014a and KNBS, 2014a
Mobile money (MOB_DUM)	A dummy variable that takes on a value of 0 for the period before mobile money was introduced (2000q:1-2006:q4) and a value of 1 for the period with mobile money use(2007:q1-2014:4)	MOB_DUM	

Chapter 4

Mobile Money and Consumption Patterns in Ugandan Households

4.1 Introduction

Developing countries particularly in Sub-Saharan Africa, usually have financial markets that are not well developed. As a result, individuals often rely on informal methods to access financial services. In the last few years, however, this region has seen development of financial innovations such as ATM cards, debit cards, and, most recently, mobile money[34]. These innovations have a potential to improve access to financial services and to have benefits for the real economy. Beck et al. (2012) and Laeven et al. (2015) have linked financial innovation to economic growth; and Lerner and Tufano (2011) have argued that it has an influence on households' new investment and consumption choices. Mobile money, in particular, has a potential to lower transaction costs and this could enable households to allocate their resources more efficiently and change their consumption patterns (Ramada-Sarasola, 2012).

Mobile money is not only likely to have an influence on consumer behaviour through household consumption patterns, but has a potential to affect households' consumption smoothing. Mobile money users may be able to smoothen their consumption better than non-users because they are probably more likely to insure themselves against negative shocks compared to non-users through the remittances they receive. Jack and Suri (2014) find that mobile money plays an important role in consumption smoothing as their results indicate that mobile money users are better able to insure themselves against shocks through the remittances that they receive than non-users in Kenyan households. A similar study by Munyegera and Matsumoto (2014) also finds evidence that mobile money has a positive effect on consumption in rural Ugandan households.

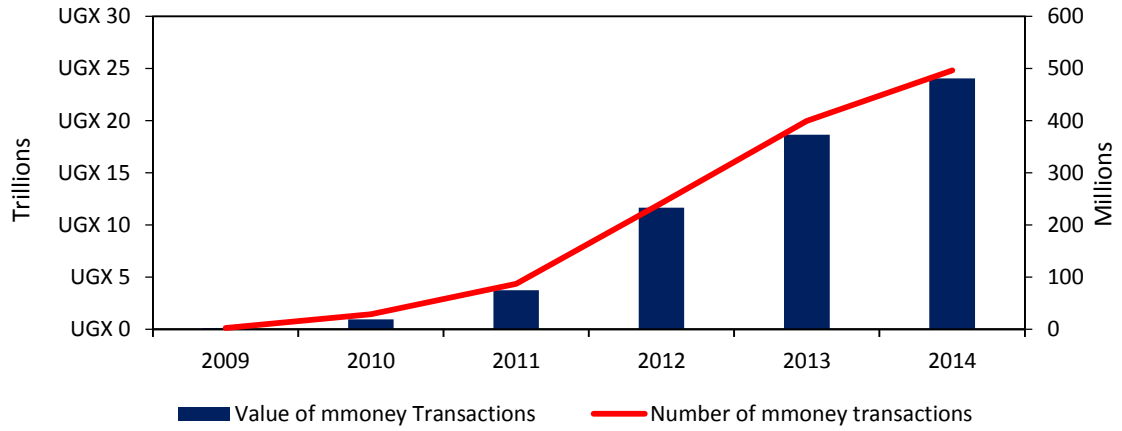
While mobile money has been found to explain consumption smoothing through remittances, the number of studies that investigate the relationship between mobile money and household consumption patterns is limited. Jack and Suri (2014) compare their results of the effect of

[34] Mobile money was first introduced in Kenya in 2007 by Safaricom and quickly spread to other countries such as Uganda, Rwanda, and Tanzania. It relies on cell phone technology and can be used to transfer money, save, pay bills and purchase goods and services without necessarily having a bank account (Jack and Suri, 2011)

mobile money on total consumption to food consumption, but fail to analyse the impact on various household consumption patterns. Similarly, Munyegera and Matsumoto (2014) also compare the effect of mobile money on food and non-food items, but fail to investigate this effect on several household consumption patterns, as their focus of the study is on household consumption per capita. Their study is limited to rural Uganda and is not representative of the country despite mobile money being popular among the urban households as well.

Uganda is an interesting case study and was considered partly due to the data limitation in Kenya. It is also one of the most successful countries in mobile money usage as it has one of the highest number mobile money users in the world. To the best of my knowledge, no studies representative of the whole country have been conducted on the effect of mobile money on consumption patterns in Ugandan households. Mobile money was first launched in Uganda in 2009 by Uganda's leading telecom company MTN. However, unlike the Kenyan success story, mobile money in Uganda did not grow as fast initially; it only picked up momentum after 2011. There were only 10,000 customers at the start in March 2009, but by November 2014, the number of customers had risen to 18.9 million people. This is more than half the population of Uganda which stands at about 37 million according to the CIA (2015). The value of mobile money has also since increased to 24 trillion Uganda shillings ($9.3billion) in 2014, up from 133 billion Uganda shillings ($65.2 million) in 2009. Similarly, the number of transactions rose from 2.8 million in 2009 to 496.3 million in 2014 as shown in Figure 6.

Figure 6: Trend in Mobile Money Values and Number of Transactions (2009-2014)



Source: Bank of Uganda (2014)

Mobile money has the potential to improve the allocation of consumption goods through the remittances received, which could have implications for economic policy. This chapter contributes to the broad literature on consumer demand theory and financial innovation by focussing on financial innovation, in particular, the effect of mobile money on household behaviour. Specifically, the effect of mobile money on household consumption patterns is investigated in this chapter. The Financial Inclusion Tracker Surveys (FITS) household level survey conducted in 2012 was employed in this analysis using the first wave of the FITS project, as it was the only wave available at the time this chapter was written. The FITS is a rich dataset that is representative of the country and not limited to the rural areas. Most importantly, it includes several vital questions related to mobile money. The rest of the chapter is structured as follows. The literature review is presented in Section 4.2 followed by the theoretical model and estimation method in section 4.3. The data is discussed in section 4.4. This is followed by the results and conclusion in sections 4.4 and 4.5, respectively.

4.2 Literature Review

Demand theory is one of the most widely well-researched areas in economics. The system of demand equations have been analysed based on consumer demand theory for a long time, dating as far back as Stone's (1954) linear expenditure system. Since then, a number of models that are an improvement of the linear expenditure system have been developed. These include the Rotterdam model, Translog model, and the Almost Ideal Demand System (AIDS) (see Deaton and Muellbauer, 1980a; Deaton and Muellbauer, 1980b). According to Deaton and Muellbauer (1980a), the Rotterdam model, proposed by Theil (1965) and Barten (1966), is one of the most frequently used specifications to test theory. The model was considered a turning point in the literature because of its features that were previously unavailable (Mountain, 1988). These include its simplicity to fully model the substitution matrix, the ease with which it relates the parameters to the restrictions of theory, and the fact that the system is linear in parameters (Deaton and Muellbauer, 1980a; Mountain, 1988). In addition, this model is only consistent with utility maximization with the use of a linear logarithmic utility function. This implies it is homothetic, additive, with constant expenditure proportions and elasticities of substitution that are constant and equal to one for all commodities (Christensen et al., 1975).

While the Rotterdam model has played an important role in the improvement of demand analysis, it is not without great criticism, especially with the development of more flexible demand functions. This specification has been found to be too restrictive and the model coefficients, according to Phlips (1974), cannot be strictly constant, except if all expenditure elasticities are equal to one and all own price elasticities are equivalent to negative one (see Deaton and Muellbauer, 1980a; Mountain, 1988). Similar to the Rotterdam model, the Translog model introduced by Christensen et al (1975), is also based on consumer theory, but it introduces quadratic utility functions. With these functions, demand theory can be tested without necessarily depending on the additivity or homotheticity assumptions. However, Deaton and Muellbauer (1980a) argue that translog models are complicated, less accurate and difficult to estimate. Moreover, just like in the Rotterdam model, the restrictions of theory still fail to hold.

The AIDS model developed by Deaton and Muellbauer (1980b), though generally similar to the Rotterdam model and the Translog model, has a few advantages over these models[35] . It allows for better aggregation over individuals, it is easier to test theoretical assumptions, such as the adding up restriction, homogeneity of degree zero and symmetry, and it has a functional form that is consistent with household budget data (Nevo, 2010; Deaton and Muellbauer, 1980b). The AIDS model was further developed by Banks et al. (1997) into the quadratic AIDS (QUAIDS) model, which is also consistent with consumer theory. Unlike AIDS model, however, it is quadratic in the log of expenditure.

Empirically, demand analysis is usually investigated using either time series data, which is more concerned with price effects than changes in income, and cross section data, which concentrates more on change in income and less on price variation (Barnett and Serletis, 2008). While the demand analysis seems to concentrate on price effects, the family budget data often assumes prices to be the same for all households, and it is more concerned with household composition effects and the nature of Engel curves (Deaton, 1997)[36] . In cross section studies, the demand function can be modified as a function of total expenditure, often referred to as the Engel curve (Deaton and Muellbauer, 1980a).

[35] However, according to Barnett and Serletis'(2008) survey, the Rotterdam model seemed to outperform the linearized version of the AIDS model based on monte carlo simulations

[36] Deaton (1997) further argues that one of the differences between demand analysis and family budget analysis is the uniformity of prices in family budget analysis.

Since there has not been a consensus on the best functional form of Engel curves in the literature, despite their popularity and relevance, a number of functional forms have been proposed. For example, one of the earlier studies by Prais and Houthakker (1955) employed the double logarithmic and the semi-logarithmic functions, while Houthakker (1957) used the double logarithmic Engel curve and argued it allowed for easier inclusion of the family size effects. Similarly, more recent studies such as Ndanshau (1998-2001) used both the linear and the double log functions. Banks et al. (1997), on the other hand, used the quadratic Engel curves. Deaton and Muellbauer, (1980a) argue that the Working-Leser model, one of the most popular forms of the Engel curves that relate budget shares linearly to the log of expenditure is appropriate, especially for cross section studies since it complies to the adding up restriction of demand analysis[37].

Given the scarcity of data especially in developing countries, most studies have often relied on cross section data and assumed same prices across households. For example, Burney and Khan (1991) analyse consumption patterns using Engel's curve in Pakistan, and Ndanshau (1998-2001) investigates whether Engel's law holds for Tanzania. Engel's law states that as income increases, the proportion of income spent on food falls (Houthakker, 1957). Earlier studies investigated this relationship with consideration of income as the only explanatory variable of the Engel curve. Several extensions of the Engel curve have been considered, starting with the inclusion of the household size (see Houthakker, 1957; Burney and Khan, 1991). Demographic variables such as occupation, age, sex, urbanisation and education have since been included as independent variables as well (see Subramanian and Deaton, 1991; Ndanshau, 1998-2001; Phipps and Burton, 1998).

While income and demographic variables are important variables in explaining expenditure patterns, the literature has advanced over the years with inclusion of additional explanatory variables into the system of demand equations. For example, Maitra and Ray (2003) find that private transfers play an important role in explaining household expenditure patterns in South Africa. According to them, these households were more likely to see an increase in the budget share necessities such as food and clothing. Similarly, Adams Jr and Cuecuecha (2010) find that

[37] An example of the Working- Lesser model depicted by Deaton and Muellbauer (1980a), $\omega_i = \alpha_i + \beta_i log x$ indicates budget shares ω_i and expenditure x. In addition, the adding up restrictions in this case imply that $\sum \omega_i$ =1, $\sum \alpha_i$ =1, and $\sum \beta_i$ =0.

remittances are also an important variable in explaining consumption patterns. Their analysis showed that Guatemala households that received remittances were more likely to spend more on specific goods, in particular, investment goods, such as education and housing, compared to households that did not receive remittances.

Remittances have been found to be an important variable in explaining household consumption patterns. Despite this, few studies have considered mobile money technology that is mainly used to send and receive money as a potential explanatory variable. Most of the studies on mobile money have relied on its effect on consumption or welfare. These include Jack and Suri (2014) who find evidence of consumption smoothing among M-PESA users in Kenya and Munyegera and Matsumoto (2014) who also find evidence that mobile money has a positive effect on consumption in rural Ugandan households largely due to the remittances received. One of the reasons for the few studies is the lack of data to understand the implications of mobile money on household consumption patterns in the developing countries that have successfully used this technology. Mobile money could potentially affect consumer behaviour through remittances received in two ways.

First, remittances received through mobile money could be used to smoothen consumption when a temporary shock occurs. Deaton (1997) argues that households can insure themselves against temporary shocks through short term consumption smoothing. Since households, particularly the poor have undeveloped financial markets, are unbanked, often have incomplete or imperfect markets, and lack formal means of insurance to help guard against uncertainties, as a result, these households are more likely to insure themselves through informal methods. The informal insurance methods the poor households engage in are likely to be incomplete. Jack and Suri (2014) argue transaction costs could explain this incompleteness. These low income countries, thus, often become innovative in finding a variety of ways to protect themselves against risk (Morduch, 1995). They are more likely to rely on informal means such as new financial innovations like mobile money to insure themselves from income shocks. Indeed, Jack and Suri (2014) find evidence that Kenyan households were able to insure themselves against risk through the use of M-PESA. When they compared households with M-PESA to those without, they found that consumption of users was unaffected by shocks, while those for non-users had a 7 percent decline in consumption. Ugandan households are no exception to these temporary shocks

as they have limited access to financial markets and heavily rely on agriculture that is susceptible to pests and crop diseases in addition to other shocks, such as death and disease. In Munyegera and Matsumoto's (2014) study, consumption per capita increased by 69 percent for mobile money users in rural Ugandan households. This suggests that households with mobile money are able to smoothen their consumption better than non-users. The studies all argued that remittances played a role in the change in consumer behaviour of mobile money users.

While both of these studies – i.e. Jack and Suri (2014) and Munyegera and Matsumoto (2014) – are informative in understanding the effect of mobile money on consumption, they do not investigate the effect of mobile money on household consumption patterns. Jack and Suri (2014) fail to address the issue of potential re-allocation of resources to particular goods, such as necessities and luxuries due to the remittances received from mobile money. Munyegera and Matsumoto (2014) do not focus on the effect of mobile money on the demand for various household goods per se, but rather concentrate on the effect of mobile money on welfare using consumption per capita as their measure for welfare. Moreover, the country is not well represented as only rural Uganda is considered. This is despite the fact that mobile money is popular in the urban areas as well. To determine how well mobile money users smooth their consumption, at least two time periods are required. In other words, households may receive the remittances say in period one and save it for use when a shock occurs say in period two. However, investigating consumption smoothing of mobile money users over time is not feasible with only one time period for this study.

Another way mobile money could potentially affect consumer behaviour through the remittances received is in the change of household consumption patterns. Remittances could potentially lead to a rise in income, which could have an impact on household consumption patterns. When households experience an increase in income as a result of remittances received from mobile money, they are likely to spend more on particular goods, such as luxuries, and less on necessities, such as food. Thus, mobile money has the potential to enable households to allocate their resources more efficiently and change their consumption patterns due to the remittances received (Ramada-Sarasola, 2012). Given the data limitation, this analysis can be carried out using one time period, unlike the investigation of the likely impact on consumption smoothing

that would require at least two time periods. The next section develops the theoretical model and estimation method.

4.3 Theoretical Model and Estimation Method

Understanding the effect of mobile money on household consumption patterns is important given the dearth of studies. In addition, it has important implications for economic development. These demand functions are generated using the standard maximization of utility functions which are consistent with consumer theory. Following Deaton and Muellbauer (1980a), the utility maximization function depicted below is used to generate the demand functions.

$$\text{Maximize} \quad u = u(y_1, y_2, y_3, y_4 \ldots . y_n) \tag{6}$$

s.t

$$\sum p_i y_i = \text{x}$$

Where u represents the utility, y represents the goods consumed and p represents the price of goods, and x is the total expenditure. Following utility maximization in equation (6), the traditional demand function generated is as depicted in equation (7) below.

$$y_i = f_i \text{ (x,p)} \tag{7}$$

As indicated in equation (7), demand is a function of price and expenditure. As earlier mentioned in the literature, prices are assumed to be similar for all households in cross section data. Thus, the functional form in equation (7) can be adjusted to capture the identical prices by all households which Deaton and Muellbauer (1980a) refers to as the Engel curve depicted in equation (8)

$$y_i = f_i^* \text{ (x)} \tag{8}$$

The Engel curve originally contained income as the only explanatory variable with the assumption of constant price as indicated in equation (8). However, there have been several modifications of the Engel curve since then. For example, Houthakker (1957) and Burney and Khan (1991) included the household size as a relevant explanatory variable, while other studies such as Subramanian and Deaton (1991), Ndanshau(1998-2001), and Adams Jr and Cuecuecha

(2010) controlled for additional demographic variables. An additional variable, mobile money, ought to be included in the Engel curve since mobile money user households are more likely to receive remittances which could increase income and thus affect household demand for various goods. Thus equation (8) can be modified to include mobile money (m) and other control variables (z) based on theory as depicted in equation (9):

$$y_i = f_i^* (x,m,z) \tag{9}$$

This chapter employs the functional form of the Working Leser model with linear budget shares and logged total expenditure since it is consistent with the adding up restriction (Deaton and Muellbauer, 1980a). Thus, the Engel curve in equation (9) can be modified as the Working Leser model and it can be re-written as equation (10):

$$\omega_i = \alpha_i + \beta_i lnx + \theta_i m + \delta' z + \varepsilon_i \tag{10}$$

where ω_i the dependent variable, is the share of consumer good i which include food, clothing, housing, transport, medical and miscellaneous shares. As theory predicts, the adding up restrictions are met if $\sum \omega_i$ =1, $\sum \alpha_i$ =1, and $\sum \beta_i$ =0. x represents the total expenditure, while m represents the variable of interest, mobile money. z stands for a vector of control variables including household size, age, urban dummy, gender dummy and education attainment . The disturbance term is represented by ε_i, while α_i represents the constant term for each consumer good i.

The equation (10) is estimated using Ordinary Least Squares (OLS) and the Seemingly Unrelated regression (SURE), which is used as a robustness check. OLS is well known as the best linear unbiased estimator and widely used in modelling consumption patterns (see for example Houthakker, 1957; Subramanian and Deaton, 1991). One limitation, however, is that the error terms between the separate consumer good equations could be correlated, which may potentially lead to inefficiency. The SURE is sometimes preferred to the OLS equation by equation estimation because it not only estimates these equations as a system, but also uses feasible generalized system of Equations (FGLS) which could produce more efficient estimates than OLS (Cameron and Trivedi, 2009; Cameron and Trivedi, 2005). However, if no evidence of correlation between the error terms of the various equations is found, then OLS is preferred. Cameron and Trivedi (2005) argue that in addition to efficiency gains through the inclusion of the correlation in unobservables across equations for an individual, joint estimation may also be

useful, especially with cross equation parameter restrictions that may not be possible with the equation by equation OLS estimation. The Breusch-Pagan test for independence is used to determine if the errors from the different equations are correlated.

The results from the OLS and SURE estimates could easily be used to identify the type of consumer goods, for example, the coefficient on income (total expenditure) that measures income elasticity can be either positive ($\beta_i > 0$) for luxury goods or negative ($\beta_i < 0$) for necessities[38]. (see Deaton and Muellbauer, 1980a; Izan and Clements, 1979; Subramanian and Deaton, 1991). One would also expect Engel's law to hold as depicted by most studies in the literature. A good example is Houthakker's (1957) findings which depicted food as a necessity and clothing as a luxury good. Houthakker's (1957) study uses household data from a wide range of developed and developing countries. Additional studies, especially from developing countries such as Burney and Khan (1991) for Pakistan households and Ndanshau (1998-2001) for Tanzania, also find that food is indeed a necessity because as income rises, less money is spent on food.

All these studies confirm that Engel's law holds. The household size also has a particularly interesting economic significance. A variety of studies have found two different effects on consumption goods, which Houthakker (1957) refers to as the 'specific effect' and the 'income effect'. In the specific effect, households have economies of scale and have a tendency to demand more of a commodity. In contrast, the income effect shows that households become poorer with a larger household size and demand less. One may also expect households with mobile money to spend less on food items and more on other items, because they tend to receive more remittances than non-members. In other words, they should be expected to allocate their resources more efficiently and change their consumption patterns due to the increase in the number of remittances (Ramada-Sarasola, 2012).

[38] Total expenditure is often used as a proxy for income in consumption pattern studies since most developing countries lack data on income. Moreover, when available, it is generally susceptible to measurement errors (Houthakker,1957; Burney and Khan,1991)

4.4 Data

While mobile money has been found to be an important factor in understanding household behaviour, with studies such as Jack and Suri (2014) finding mobile money to play an important role in households' consumption smoothing, a limited number of studies have considered the effect of mobile money on household consumption patterns in Uganda. Moreover, the few studies conducted such as Munyegera and Matsumoto (2014) are not representative of the country. This could be partly due to the limited data availability in the past. More recently, however, a rich data set that is representative of the country exists, it is not limited to the rural areas, and most importantly it includes several vital questions relating to mobile money. This dataset is referred to as the Financial Inclusion Tracker Surveys (FITS) Project and only the first wave is considered for this chapter.[39] FITS is a "partnership between global research non-profit intermedia and Bill and Melinda Gates foundation's financial services for the poor program" (FITS, 2012).

This survey includes 3000 Ugandan households who were randomly sampled from 300 enumeration areas using equal probability sampling techniques (FITS, 2012). The survey was conducted in 2012, a time period that is quite relevant since mobile money use in Uganda only started increasing tremendously after 2011. FITS is a household level survey, and certain variables such as age, education, gender and occupation that are difficult to capture on a household level, the head of household was used as a representative of the household data. This study also excludes households with any missing data, those who recorded more than 1 head of household, and those that either refused to answer a question, or answered "do not know" to a question. With these adjustments, the data that was finally used in this analysis contained less than 3000 households. The details of the variable description are depicted in Table 19.

[39] At the time this chapter was written, only the first wave out of three waves was released.

Table 19: Variable Description

Variable	Variable Description
Mobile Money	1 if at least one mobile money user in the household, 0 otherwise
Household Size	Number of individuals in the household
Age of Head of Household	Age of household head > or = 15 years(Adults)
Urban/Rural Dummy	Urban/rural dummy 1 for urban 0 rural
Gender of Household Head	Gender of household head 1 female 0 male
Mobile Phone Ownership	1 if at least one person in the household owns a mobile phone, 0 otherwise
Mobile Phone Use	1 if at least one person in the household uses a mobile phone, 0 otherwise
Storage/Saving Instruments	
Bank Account	1 if at least one household member stores/saves money in the bank or MDI/MFI, 0 otherwise
Mattress	1 if at least one household member stores/saves money in the mattress/cashbox/hiding place, 0 otherwise
Sacco	1 if at least one household member stores/saves money in the Sacco,0 otherwise
Merry go round/informal group	1 if at least one household member stores/saves money in the merry go round/informal, 0 otherwise
VSLA(village savings and loan)	1 if at least one household member stores/saves money in the VSLA,0 otherwise
Mobile Money Account	1 if at least one household member stores/saves money in the mobile money account, 0 otherwise
Family Member	1 if at least one household member stores/saves money with family/friend, 0 otherwise
Advance purchase/shopkeeper deposit	1 if at least one household member stores/saves money with advance purchase/shopkeeper, 0, otherwise
Stocks and Shares	1 if at least one household member stores/saves money in shares/stocks,0 otherwise
Pension/Retirement fund	1 if at least one household member stores/saves money in pension/retirement fund, 0 otherwise
Remittances Received	1 if at least one household member received remittances(money) and 0 otherwise
Remittances Sent	1 if at least one household member sent remittances(money) and 0 otherwise
Education Attainment of Household Head	
No Education	0 if no formal education
Primary School	1 if primary formal school is the highest education attainment
Secondary School	2 if secondary formal school is the highest education attainment
Tertiary/University	3 if tertiary formal university is the highest education attainment
Occupation of Household Head(main)	
Farmer/Farm worker	0 if farmer/farm worker
Professional	1 if professional
Business/Shop Owner	2 if business/Shop owner
Other	3 if other
Unemployed	4 if unemployed
Public/Health Service worker	5 if public/health service worker
Carpenter/Mason	6 if carpenter/mason
Driver	7 if driver
Tailor	8 if tailor
Bodaboda (motorcycle taxi)	9 if bodaboda (motorcycle taxi)
Consumption Shares	
food share	Annual food expenditure/ Annual total expenditure
clothing share	Annual clothing expenditure/ Annual total expenditure
housing share	Annual housing expenditure/ Annual total expenditure
transport share	Annual transport expenditure/ Annual total expenditure
medical share	Annual medical expenditure/ Annual total expenditure
miscellaneous share	Annual miscellaneous expenditure/ Annual total expenditure
Total Expenditure (Shs.)	Annual Total Expenditure (in Uganda Shillings)

Source: FITS (2012)

Table 20: Summary Statistics (ALL)

Variable	Obs	Mean	Std.Dev.	Min	Max
Mobile Money	2,370	0.26	0.439	0	1
Household Size	3,000	4.953	2.581	1	12
Age of Head of Household	2,917	42.27	15.14	15	95
Urban/Rural Dummy	3,000	0.133	0.34	0	1
Gender of Household Head	2,942	0.253	0.435	0	1
Mobile Phone Ownership	2,370	0.805	0.396	0	1
Mobile Phone Use	2,997	0.791	0.407	0	1
Storage/Saving Instruments Dummy Variables					
Bank Account	3,000	0.17	0.375	0	1
Mattress/cashbox/hiding place/other	3,000	0.667	0.471	0	1
Sacco	3,000	0.104	0.305	0	1
Merry go round/informal group	3,000	0.280	0.449	0	1
VSLA(village savings and loan)	3,000	0.062	0.241	0	1
Mobile Money Account	3,000	0.086	0.281	0	1
Family Member/Friend	3,000	0.097	0.296	0	1
Advance purchase/shopkeeper deposit	3,000	0.030	0.172	0	1
Stocks and Shares	3,000	0.021	0.142	0	1
Pension/Retirement fund	3,000	0.005	0.0728	0	1
Remittances Received	3,000	0.209	0.407	0	1
Remittances Sent	3,000	0.237	0.426	0	1
Education Attainment of Household Head(percent)					
No Education	2,942	0.222	0.416	0	1
Primary School	2,942	0.458	0.498	0	1
Secondary School	2,942	0.258	0.438	0	1
Tertiary/University	2,942	0.062	0.24	0	1
Occupation of Household Head(percent)					
Farmer/Farm worker	3,000	0.669	0.471	0	1
Professional	3,000	0.046	0.21	0	1
Business/Shop Owner	3,000	0.071	0.257	0	1
Other	3,000	0.118	0.323	0	1
Unemployed	3,000	0.010	0.0979	0	1
Public/Health Service worker	3,000	0.012	0.11	0	1
Carpenter/Mason	3,000	0.036	0.187	0	1
Driver	3,000	0.013	0.115	0	1
Tailor	3,000	0.012	0.11	0	1
Bodaboda(motorcycle taxi)	3,000	0.012	0.107	0	1
Consumption Shares					
food share	2,999	0.754	0.173	0	1
clothing share	2,999	0.060	0.0951	0	0.839
housing share	2,999	0.044	0.0731	0	0.715
transport share	2,999	0.053	0.0727	0	0.855
medical share	2,999	0.044	0.0827	0	0.8
miscellaneous share	2,999	0.045	0.0571	0	0.75
Total Expenditure (Uganda Shs.)	3,000	4,926,000	4,644,000	0	60,600,000

Source: FITS (2012)

While some variables were captured as dummy variables (such as mobile money, urban/rural dummy, gender, mobile phone use, mobile phone ownership, storage instruments, remittances sent and received), other variables were captured as categorical variables (for example, the

education attainment and occupation). The household size was measured as the total number of individuals in the household, and age was captured based on the age of the adult head of household (at least 15 years). Only food and non-food commodities were considered for the total annual expenditure on consumption goods. [40] The total expenditure was constructed by summing up the food and non-food expenditures. The questionnaire retrieved food expenditure based on the last 7 days, thus, the total food consumption for the year was derived by multiplying the total weekly consumption by 52 weeks in a year.

In addition, the food expenditure also included the values of goods consumed in form of gifts and own production. The various total non-food expenditures were divided into five categories: clothing (including footwear), housing (including utilities), transport, medical, and miscellaneous. These were captured on a monthly basis, and to retrieve annual total non-food expenditures, the monthly expenditures were multiplied by 12 for these commodities.

The food share and the non-food expenditure (consumption) shares were derived by simply taking the ratio of food expenditure to total expenditure and non-food expenditure to total expenditure, respectively. The consumption shares all sum up to 1 as depicted in the summary statistics in Table 20, with the food share making up the largest percentage (75.4%). This implies that the majority of the Ugandan households surveyed spend most of their income on food items compared to non-food items.

This is especially true for the bottom poor. As depicted in Table 21 (full sample), the bottom 2 quintiles (quintile 1 and 2 with the lowest 40 percent), who are the poorest, spent 17.4 percent of the total food expenditure and only 6.3 percent of the total non-food expenditure. In contrast, the richest 40 percent spent more on non-food than food items. In other words, they spent only 66 percent of the total food expenditure and 84.4 percent of the total non-food expenditure. These quintiles further clarify the fact that the rich spend more on non-food items, while the poor spend more on food items. An indication that food is indeed a necessity is shown through the fact that

[40] Durable goods as a consumption category were dropped. Deaton and Muellbauer (1980a) argue that there is no real consensus on how durable goods should be treated with some studies dropping the variable while others include it. However, what is clear, they say, is the fact that these durables often last more than 1 year, they are not bought as frequently, and the purchases of these durables do not always equal consumption. Therefore, durables were excluded from this analysis since this data only considers cross section data for 1 year, and food and non-food items are more frequently bought compared to durable goods.

as income increases, less is spent on food. Most of the total expenditure is spent by the top 40 percent that make up 68.9 percent of the expenditure, while the bottom 40 percent only comprises of 15.9 of the total expenditure. These statistics are similar to the World Bank (2015) data that indicates that the income share by the top 40 percent makes up 69.85 percent and 16.15 percent for the bottom 40 percent. This suggests that the FITS data is representative of the Ugandan households.

Understanding the differences in expenditure between mobile money users and non-users is essential in understanding consumer behaviour. As a result, the two quintile groups were investigated as depicted in Table 21. The percentage of users and non-users increases by expenditure quintile, a result similar to the discussion of the full sample. Similarly, Jack and Suri (2011) also found that the percentage of M-PESA users increased by expenditure quartile. As already discussed in the literature, mobile money users are expected to have higher expenditures (income) due to the remittances that they receive. This appears to be true because on average, mobile money users spend more than non-users with a slightly lower percentage (17.5%) on food items for the bottom 40 percent compared to non-users (18%), and a slightly higher percentage (85%) for the top 40 percent on non-food items compared to non-users (84%) (see Table 21 for mobile money users and non-user). This is an indication that mobile money users spend more on non-food items and less on food items compared to non-users. The details of the quintiles in Uganda shillings are also depicted in Table 22.

Table 21: Mobile Money Use across Quintiles (in Percent)

	Full Sample(Mean)			Mobile Money Users(Mean)			Mobile Money Non- Users(Mean)		
Quintiles	Total Expend	Food	Non Food	Total Expend	Food	Non Food	Total Expend	Food	Non Food
1	5.6%	6.2%	1.6%	6.3%	6.6%	1.6%	5.9%	6.5%	1.7%
2	10.3%	11.2%	4.7%	10.1%	10.8%	4.5%	10.6%	11.5%	4.8%
3	15.1%	16.2%	9.3%	14.7%	15.5%	9.1%	15.4%	16.8%	9.4%
4	22.2%	23.1%	19.1%	21.5%	22.6%	18.7%	22.8%	23.7%	19.3%
5	46.7%	43.3%	65.3%	47.5%	44.4%	66.0%	45.3%	41.6%	64.7%

Source: Author's computations from FITS (2012)

Table 22: Mobile Money Use across Quintiles (in Millions of Uganda Shillings)

	Full Sample(Mean)			Mobile Money Users(Mean)			Mobile Money Non- Users(Mean)		
Quintiles	Total Expend	Food	Non Food	Total Expend	Food	Non Food	Total Expend	Food	Non Food
1	1.380	1.060	0.118	1.606	1.186	0.130	1.422	1.085	0.128
2	2.542	1.917	0.351	2.583	1.938	0.357	2.547	1.912	0.351
3	3.727	2.783	0.697	3.776	2.777	0.718	3.715	2.800	0.695
4	5.458	3.961	1.433	5.507	4.031	1.481	5.481	3.949	1.419
5	11.500	7.431	4.888	12.200	7.935	5.216	10.900	6.938	4.762
Total	4.926	3.430	1.496	7.676	4.826	2.851	4.662	3.286	1.376

Source: Author's computations from FITS (2012)

One of the reasons that could potentially explain the higher expenditures of mobile money users is remittances. In order to use mobile money services to receive these remittances, and for any other services, one must use a mobile phone. The summary statistics (Table 20) indicate that there is a difference between phone ownership and phone usage. 79 percent of the households use a mobile phone, while 81 percent of the households own at least a mobile phone. Out of the mobile money users, some households do not own a mobile phone (2%), as indicated in Table 23. According to the FITS data, half of those who do not own a mobile phone, borrow a phone to access mobile money. The large number of mobile phone ownership and usage could also partly explain the growth in mobile money services. Although mobile money households only make up about 26 percent of the data used (see Table 20), these households receive 39 percent of total remittances compared to only 17 percent received by non-users (see Table 23). However, this does not imply that all remittances received by mobile money user households are received via mobile money. Out of the 39 percent of the total remittances, a large percentage (77 percent) of this is received via mobile money. This further clarifies the argument that mobile money users on average receive more remittances than non-users. Mobile money users also sent more remittances than non-users, an indication that most mobile money user households use mobile money technology to send and receive money (see Table 23).

This is also insinuated in the low savings/storage rates for mobile money users (8.6%) (see Table 20). Uganda is a cash economy and the majority of households still save or store money under

the mattress or cash box (67%) with only (17%) saving their money in the bank account (see Table 20). Interestingly, there are more mobile money users that have bank accounts compared to non-users with 43 percent of mobile money users saving or storing money in bank accounts, while only 13 percent of non-users use bank accounts, as depicted in Table 23. The data also indicates that there are more female headed households that use mobile money than non-users with 24 percent and 22 percent, respectively. These percentages are slightly smaller than the average percentage of female headed households that stands at 25 percent based on the overall data in Table 20. This percentage is close to the data from the World Bank (2015) which depicts that 29.5 percent of households are headed by females. This suggests that the data is representative of the country.

Table 23: Summary Statistics of Mobile Money Users and Non-Users[41]

	Mobile Money Users			Non-Mobile Money Users		
Variable	Obs	Mean	Std.Dev.	Obs	Mean	Std.Dev.
Household Size	616	5.13	2.46	1754	5.15	2.62
Age of Head of Household	602	40.39	13.14	1700	40.93	14.17
Urban/Rural Dummy	616	0.33	0.47	1754	0.10	0.30
Gender of Household Head	602	0.24	0.43	1717	0.22	0.42
Mobile Phone Ownership	616	0.98	0.14	1754	0.74	0.44
Mobile Phone Use	616	1.00	0.00	1754	1.00	0.00
Bank Account	616	0.43	0.50	1754	0.13	0.34
Remittances Received	616	0.39	0.49	1754	0.17	0.37
Remittances Sent	616	0.46	0.50	1754	0.20	0.40
Education Attainment of Household Head						
No education	602	0.08	0.28	1717	0.21	0.41
Primary School	602	0.28	0.45	1717	0.51	0.50
Secondary School	602	0.45	0.50	1717	0.25	0.43
Tertiary/University	602	0.19	0.40	1717	0.03	0.18
Occupation of Household Head						
Farmer/Farm worker	616	0.42	0.49	1754	0.69	0.46
Professional	616	0.12	0.32	1754	0.03	0.18
Business/Shop Owner	616	0.13	0.34	1754	0.07	0.26
Other	616	0.22	0.41	1754	0.10	0.30
Unemployed	616	0.01	0.11	1754	0.00	0.06
Public/Health Service worker	616	0.02	0.15	1754	0.01	0.11
Carpenter/Mason	616	0.03	0.18	1754	0.04	0.21
Driver	616	0.03	0.17	1754	0.01	0.11
Tailor	616	0.01	0.11	1754	0.01	0.11
Bodaboda(motorcycle taxi)	616	0.00	0.07	1754	0.02	0.13

Source: FITS (2012)

In Table 20, Ugandan households were found to have approximately 5 individuals per household on average, with an average adult age of 42. While the majority of the households had some

[41] These results show minor differences between users and non-users even when tested statistically.

formal education, 22 percent of the households did not have any formal education. The majority of the households had at least a primary level education (46%), 26 percent had a secondary school level education, and only 6 percent had tertiary level education. Although the data contains only 13 percent of urban areas (see Table 20), there are more mobile money users located in urban areas (33%) than non-mobile money users (10%), as depicted in Table 23. This suggests that it is important to analyse mobile money with consideration of both urban and rural areas to have a complete understanding of the effect of mobile money on household behaviour. Uganda's economy is largely based on agriculture. Thus, it is not surprising that the most popular occupation in the sample is farming (67%), as depicted in Table 20, with only 1 percent of the households in the sample unemployed. Most of these variables discussed do have a potential to affect the demand for household commodities, and this is especially true for the mobile money variable. The results of the various demand equations are discussed in the next section.

4.5 Results

The effect of mobile money on household consumption patterns is investigated using two estimating techniques: the ordinary least squares (OLS) and the seemingly unrelated regressions (SURE)[42]. The SURE is used as a robustness check to test for the sensitivity of these results[43]. The analysis starts off with a discussion of the OLS results depicted in Table 24 followed by the SURE results in Table 25. One might expect poor households to demand more food and less non-food items compared to rich households, which are expected to demand less food and more non-food items, as inferred in the data section. Indeed, the OLS results in Table 24 depict a similar picture with expenditure highly significant and negatively related to food, while positively related to clothing, transport and medical goods. These results indicate that food is a necessity, while clothing, transport and medical goods are considered luxury goods. This

[42] OLS and SURE were specifically chosen over other methods including the quasi experimental design approach partly because of the fact that the FITS data used is not derived from a quasi-experimental design and only one wave has so far been considered.

[43] Although OLS is widely used in modelling consumption patterns (see for example Houthakker, 1957; Subramanian and Deaton, 1991), the error terms between the separate consumers equations could be correlated leading to inefficiency. Thus, SURE can help correct for this inefficiency as they employ FGLS.

suggests that Engel's law holds for Ugandan households. These results are similar to empirical evidence in both developed and developing countries that found evidence that Engel's law holds, such as Ndanshau (1998-2001) for the case of Tanzania and Houthakker (1957) for 30 countries, and Burney and Khan (1991) for rural and urban Pakistan households. Although the expenditure (income) is positively related to the housing and miscellaneous goods in Table 24, implying they are luxury goods, the coefficients are surprisingly insignificant.

Mobile money, the main variable of interest is statistically significant and negatively related to food and clothing. It is also significant for the housing and transport goods, but with positive coefficients (see Table 24). However, the medical and miscellaneous goods are insignificant. These results suggest that households that use mobile money spend less on necessities, such as food, and spend more on luxury goods, such as housing and transport, compared to households that do not use mobile money. Again, this is not surprising given the fact that these households on average are well off compared to non-users due to the additional remittances they receive. Therefore, they can afford to spend more on luxury goods (with the exception of clothing) than non-users. The household size is also significant and positively related to food while negatively related to non-food items, such as housing and miscellaneous goods (see Table 24). This means that the specific effect due to economies of scale described by Houthakker (1957) appears to be stronger than the income effect for Ugandan households. In other words, larger households benefit from economies of scale and thus demand more commodities; in this case, they demand more food.

Surprisingly, gender is insignificant for food items, but positive and highly significant for housing goods and negatively related to clothing and transport items. These OLS results suggest that female headed households spend more on housing than males; they also spend less on clothing and transport goods than male headed households. Age appears to play a minor role in determining food consumption patterns and while it is statistically significant and negatively related to clothing, it is positively related to medical and miscellaneous shares. The size of the coefficient in all aspects is relatively small. This could suggest that while older household heads demand less clothing and more medical and miscellaneous goods, the impact is quite small.

Table 24: Effect of Mobile Money on Consumption Patterns using OLS

	(1) Food share	(2) Clothing share	(3) Housing share	(4) Transport share	(5) Medical share	(6) Misc share
Mobile Money	-0.017**	-0.009*	0.018***	0.008*	-0.000	0.001
	(0.008)	(0.005)	(0.003)	(0.004)	(0.004)	(0.003)
Log of Total Expenditure	-0.066***	0.037***	0.003	0.008***	0.016***	0.000
	(0.005)	(0.003)	(0.002)	(0.003)	(0.003)	(0.002)
Urban/Rural Dummy	-0.067***	-0.016***	0.093***	0.002	-0.010*	-0.003
	(0.010)	(0.006)	(0.004)	(0.005)	(0.005)	(0.004)
Household Size	0.004***	-0.001	-0.003***	-0.000	0.001	-0.001**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Age of Head of Household	0.000	-0.0005***	-0.000	-0.0001	0.0003**	0.0003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Education Attainment of Household Head						
Primary School	-0.023**	0.015***	-0.000	0.014***	-0.007	0.002
	(0.010)	(0.006)	(0.004)	(0.005)	(0.005)	(0.004)
Secondary School	-0.038***	0.014**	0.010**	0.023***	-0.021***	0.012***
	(0.011)	(0.006)	(0.005)	(0.005)	(0.006)	(0.004)
Tertiary/University	-0.085***	0.010	0.042***	0.026***	-0.026***	0.034***
	(0.016)	(0.009)	(0.007)	(0.008)	(0.008)	(0.006)
Gender of Household Head	0.011	-0.014***	0.012***	-0.014***	0.005	0.000
	(0.008)	(0.005)	(0.003)	(0.004)	(0.004)	(0.003)
Constant	1.750***	-0.486***	-0.011	-0.077**	-0.203***	0.027
	(0.080)	(0.046)	(0.033)	(0.038)	(0.041)	(0.029)
Observations	2301	2301	2301	2301	2301	2301
F-statistic	52.832***	23.930***	127.959***	10.705***	8.743***	7.033***
R-Squared[44]	0.172	0.086	0.335	0.040	0.033	0.027

*Dependent variable: Share of consumer good i which includes food, clothing, housing, transport, medical and miscellaneous shares*p-value<0.10, **p-value<0.05, ***p-value<0.01 (.) represent the standard errors*

As one might expect, households located in urban areas spend less on food, clothing and medical items, but spend more on housing than those households located in rural areas. The coefficients of the urban variable is highly significant at a 1% level for food, clothing, and housing shares, but only significant at a 10 % level for the medical share. Although there are fewer urban areas than rural areas in the dataset, urban areas appear to have larger expenditures and thus more willing to spend more on luxury goods, such as housing, and less on necessities, such as food. One possible reason that could explain urban areas demanding fewer medical items could be due

[44] A low R-squared is not unusual in these types of studies.

to the fact that rural areas are largely comprised of poor people who are prone to diseases. As a result, they spend a reasonable amount of their expenditure on medical goods compared to households in urban areas.

Households with any level of education spend less on food than households without education, but spend more on transport items than those without an education. Education is highly significant for most of these commodities, except primary level education, which is insignificant for housing, medical and miscellaneous commodities. Tertiary level education is insignificant for clothing. In contrast, secondary education is significant for all commodities. The highly educated (secondary and university) demand more housing items and miscellaneous goods than the uneducated; they also demand less medical goods than households with no education. This suggests that households with higher education are probably more financially stable and less likely to fall sick. Consequently, they can afford to spend more on housing and less on medical items. Finally, primary and secondary school education is statistically significant and positively related to clothing, an indication that these households demand more clothing items compared to households with no education.

While the OLS results appear to show a good fit with most of the variables significant, and the F-statistic highly significant as well, these results may be inefficient. Thus, the Seemingly Unrelated Regressions (SURE) is considered to check for robustness. The SURE uses the Feasible Generalised Least Squares (FGLS) to correct for inefficiency if the errors are found to be correlated across the equations. With the SURE, one of the equations would have to be dropped in order to retrieve the estimates because of the adding up restriction (Cameron and Trivedi, 2005). Thus, the miscellaneous share equation was arbitrarily dropped. Since SURE results reduce to OLS if the same number of explanatory variables are used in each equation (Cameron and Trivedi 2009), the household size, age, urban/rural dummy and gender dummy were excluded from the clothing, housing, transport and medical equations, respectively. The SURE results in Table 25 indicate that the error terms in the equations are correlated with the Breusch Pagan test of independence test which is significant at a 5 percent level. This suggests that the SURE is indeed a valid method in this particular case.

Table 25: Effect of Mobile Money on Consumption Patterns using SURE

	(6) Food share	(7) Clothing share	(8) Housing Share	(9) Transport share	(10) Medical Share
Mobile Money	-0.018**	-0.009*	0.018***	0.008**	-0.000
	(0.008)	(0.005)	(0.003)	(0.004)	(0.004)
Log of Total Expenditure	-0.065***	0.036***	0.003	0.009***	0.016***
	(0.005)	(0.003)	(0.002)	(0.003)	(0.003)
Urban/Rural Dummy	-0.066***	-0.015***	0.093***	---	-0.009*
	(0.009)	(0.006)	(0.004)	---	(0.005)
Household Size	0.004***	---	-0.003***	-0.000	0.001
	(0.001)	---	(0.001)	(0.001)	(0.001)
Age of Head of Household	0.000	-0.001***	---	-0.000	0.0003**
	(0.000)	(0.000)	---	(0.000)	(0.000)
Education Attainment of Household Head					
Primary School	-0.023**	0.015***	0.001	0.013***	-0.008*
	(0.010)	(0.006)	(0.004)	(0.005)	(0.005)
Secondary School	-0.038***	0.014**	0.011**	0.023***	-0.022***
	(0.011)	(0.006)	(0.004)	(0.005)	(0.006)
Tertiary/University	-0.086***	0.010	0.044***	0.026***	-0.028***
	(0.016)	(0.009)	(0.007)	(0.008)	(0.008)
Gender of Household Head	0.015**	-0.013***	0.012***	-0.014***	---
	(0.007)	(0.005)	(0.003)	(0.004)	---
Constant	1.745***	-0.476***	-0.016	-0.080**	-0.199***
	(0.079)	(0.044)	(0.033)	(0.038)	(0.041)
Observations	2301	2301	2301	2301	2301
R-Squared	0.172	0.086	0.334	0.040	0.033
Breusch-Pagan Test of Independence[χ^2]		1829.262***			

*Dependent variable: Share of consumer good i which includes food, clothing, housing, transport and medical shares *p-value<0.10, **p-value<0.05, ***p-value<0.01 (.) represent the standard errors*

The OLS estimates (Table 24) and the SURE estimates (Table 25) are similar for most variables, including mobile money, except for the food, transport and medical equations where the precision of specific explanatory variables improved with SURE. In particular, female headed households with the SURE equation seem to demand more food items than male headed households. This is in contrast to the OLS results where the gender coefficient was insignificant but with a positive sign. For the transport equation, the precision of the mobile money coefficient increased compared to the OLS equation. Lastly, for the medical goods equation, primary

education attainment was found to be significant in the SURE results compared to the OLS results that had primary school attainment insignificant.

In summary, both the OLS and SURE results confirm that Engel's law holds and, most importantly, that mobile money has an effect on Ugandan household consumption patterns. The results suggest that mobile money users are better able to allocate their resources more efficiently than non-users because they demand more luxury goods than necessities such as food. This indicates that mobile money can potentially improve individuals' livelihoods.

4.6 Conclusion

While mobile money has a potential to affect household consumption behaviour, few studies have investigated this relationship. Studies as Jack and Suri (2014) for Kenya and Munyegera and Matsumoto (2014) for rural Uganda find evidence that mobile money enables households to smooth their consumption through the remittances they receive, they however, fail to analyse its impact on the various household consumption patterns. Moreover, none of these studies have considered a representative sample of Uganda, despite the high number of mobile money users in the country. This chapter has contributed to the literature by investigating the effect of mobile money on household consumption patterns in Uganda, using the FITS, a country representative dataset, and employed the Ordinary Least Squares (OLS) and the Seemingly Unrelated Regression (SURE).

Mobile money users were found to demand more housing and transport items and less food and clothing than non-users. This result suggests that mobile money users are efficiently able to allocate their resources better than non-users due to the increase in income received from the remittances. In other words, they spend less on food, a necessity, and spend more on luxury goods, such as housing and transport items (with the exception of clothing).

Since there was evidence that Ugandan households demand more food as expenditure (income) increases, this indicates that Engel's law holds. The results also showed that larger households were found to demand more food than non-food commodities. This suggests that larger households often benefit from economies of scale and, thus, can afford to spend more on food.

Other important variables such as the location of the household, the education attainment and the gender of household head all play a role in the household demand for various goods. Age was found to play a minor role in the demand for various household commodities. Despite the fact that age was found to be significant for clothing, medical and miscellaneous items, it had very small coefficients.

These findings have important policy implications. Mobile money users could potentially improve their household consumption patterns given the fact that users spend less on necessities and more on luxuries. This suggests that mobile money not only enables individuals to receive more remittances, but also enables them to spend more efficiently on particular commodities than non-users. This is an indication that mobile money could potentially improve individuals' livelihoods. This study has some limitations in analysing household consumption patterns. Specifically, the FITS dataset used was only available for the first wave by the time this chapter was written and, as a result, this study could not be carried out using a panel dataset. As data becomes available, it would be interesting to investigate the effect of mobile money on various household consumption goods in order to have a clear picture of the true impact of this innovation over time, particularly its likely effect on individuals' livelihoods. Another limitation to this study, is a potential problem of the expenditure being endogenous, as observed by some studies such as Blundell et al (2007) who found that it is important to adjust for endogeneity for both non parametric curvatures and demographic parameters of Engel curves.

Chapter 5

Conclusion

This thesis has contributed to the literature of financial innovation on both a macroeconomic level and a microeconomic level. While the effect of financial innovation on money demand is well researched in the industrialised countries, there are limited studies on low income countries particularly in the Sub-Saharan African region. This is surprising given the growth of financial innovations in SSA in the last few decades. This thesis has shown that financial innovation is not only important in explaining money demand in the region, but that a specific type of innovation, mobile money, also plays a crucial role in understanding money demand. Additionally, this research has shown that mobile money has an effect on the household consumer behaviour that could potentially have implications for economic development. These issues were investigated based on three main objectives addressed in chapters two, three and four respectively. The relationship between financial innovation and money demand in Sub-Saharan Africa was investigated in chapter two. This research was further refined to include the most recent innovation, mobile money in chapter three. This chapter contributed to the literature by investigating the relationship between mobile money and money demand for the case of Kenya. This country is particularly interesting because it has been at the forefront of this unique innovation, and has been the most successful country in mobile money usage in the world. Mobile money was further investigated in chapter four using a microeconomic approach to understand the impact of this innovation on the real economy through household consumer behaviour. This chapter specifically contributed to the literature by investigating the effect of mobile money on household consumption patterns for the case of Uganda. Since data was not readily available for Kenya, Uganda was considered as it is one of the countries that has also been successful in mobile money usage since its introduction in 2009. All these three chapters are well linked by financial innovation in Sub-Saharan Africa.

In the second chapter, the relationship between financial innovation and money demand was analysed in 34 Sub-Saharan African countries between 1980 and 2010 using dynamic panel data estimation techniques. Given the limited number of studies in SSA, this chapter tried to fill the gap in the literature on financial innovation and money demand. The results indicated that

financial innovation was found to be an important variable in determining money demand and had a negative effect on the demand for money in both the long run and the short run. These results are in line with most of the literature that finds a negative relationship between financial innovation and money demand (See Nagayasu 2011, Lippi and Secchi 2009). The traditional determinants of money demand such as the opportunity cost of holding money, and income, were found to be negatively and positively related to money demand respectively as expected, based on the quantity theory of money. Introducing the exchange rate into the model indicated that it did not play a major role in determining money demand in the long run. This could be due to the fact that countries with different exchange rate regimes were included in the sample and a more detailed case study investigation of this would be valuable. Comparing the models with and without financial innovation, showed different coefficients estimates for inflation and income, as the coefficients appeared to be slightly lower for the models with financial innovation. This suggests that excluding financial innovation, may have led to biased estimates in previous studies that excluded it in the standard money demand specification. Most importantly, there was evidence of the stability of money demand since the error terms were all significant and negative despite the varying speed of adjustment across all the different panel data techniques used. These results are similar to the studies on the Sub-Saharan African region such as Hamori et al. (2008) and Salisu et al. (2013) who also found money demand to be stable despite the fact that they excluded financial innovation. While the negative financial innovation coefficient supports the notion that new innovations have led individuals to move away from more liquid assets to less liquid ones, what is true for the region may not necessarily be true for a particular country. A good example of this is the growth of mobile money in countries such as Kenya, Tanzania, and Uganda that is unique compared to other financial innovations.

This argument partly motivated the investigation into the relationship between mobile money and money demand for the case of Kenya in chapter three. This country was specifically chosen due to the fact that it has the highest number of mobile money users in the world, having been the first country to introduce this innovation. In addition, no studies to the best of my knowledge have attempted to investigate this relationship between mobile money and money demand. Using the ARDL approach to cointegration over the period 2000 Q1 to 2014 Q2, the findings indicated that there is evidence of a positive relationship between this type of innovation, mobile money and money demand, a result contradictory to the findings on Sub-Saharan Africa in chapter two

and most of the literature on financial innovation. These results were also found to be robust when different measures of mobile money were used.

A possible explanation for this positive relationship could be due to the fact that mobile money is backed up in commercial banks as deposits and because it includes both cash and an alternative form of cash (i.e. e-money), and not necessarily an alternative form of asset other than cash, there is an incentive to hold onto this new alternative form of cash rather than other assets and as a result demand for money increases. Given the fact that individuals who would have otherwise not had access to financial services such as people that used to keep money under their mattresses or those involved in barter trade prior to the introduction of mobile money, the initial effect of this innovation would lead to a positive impact on money demand. This implies, the positive effect is much stronger than the negative effect of mobile money on money demand for Kenya. Income was also found to be positively related to money demand. The interest rate, on the other hand, was only significant and negatively related to money demand in the short run when the real broad money measure was used for money demand. However, once narrow money was considered, the interest rate was negative and significant as expected from theory. This suggests that the interest rate for the case of Kenya appears to be more sensitive to M1 than M3, a result similar to Ndirangu and Nyamongo (2015) who find that interest rates are significant for M1 and M2 but not M3 for Kenya. The exchange rate was found not to play an important role in determining money demand in the long run, regardless of the type of mobile money measure used. However, in the short run, the exchange rate was significant. Money demand was found to be stable and these results were not different from chapter two where the demand for money was found to be stable as well. However, in the Kenyan case study, no evidence of a stable money demand was found at a 5 percent level of significance when mobile money was excluded. This could be an indication that the money demand equation may have been misspecified when mobile money was not taken into consideration.

Mobile money was further investigated in chapter four using a microeconomic approach. This chapter has not only contributed to the literature on financial innovation, but also on consumer behaviour as well. While studies such as Jack and Suri (2014) for Kenya and Munyegera and Matsumoto (2014) for rural Uganda find evidence that mobile money enables households to smooth their consumption through the remittances they receive, they fail to analyse its impact on

the various household consumption patterns. Using a rich dataset representative of Uganda, the 2012 Financial Inclusion Tracker Surveys (FITS) household level data survey, the Ordinary Least Squares (OLS) and the Seemingly Unrelated Regression Estimation Techniques (SURE) were employed. The most important finding showed that mobile money plays a major role in Ugandan household consumption patterns with mobile money users spending less on food, a necessity, and more on luxury goods such as housing and transport goods than non-users. These results suggest that mobile money users are more likely to efficiently allocate their resources due to the increase in income received from the remittances. Ugandan households also demanded less food as their expenditure (income) increased, implying that Engel's law holds. Hence, food was found to be a necessity good while clothing, transport and medical goods were all found to be luxuries. Larger households were also found to demand more food than non-food commodities suggesting that larger households often benefit from economies of scale and thus can afford to spend more on food. The location of the household, the education attainment, and the gender of the household head all played a role in the household demand for various goods. However, the age though significant for clothing, medical and miscellaneous items, the coefficients were very small implying age plays a minor role in the demand for various household commodities.

In summary, these three chapters indicate that financial innovation was found to have an effect on money demand with a negative or positive effect depending on the type of innovation considered. Evidence has also shown that mobile money has an effect on household consumption patterns, implying mobile money users can better allocate their resources than non-users.

These results have important policy implications for the Sub-Saharan African region. Financial innovation is important for future policy design and not accounting for it in the money demand specification could potentially lead to biased estimates. While some Sub-Saharan African countries such as Ghana, Uganda and South Africa have moved towards inflation targeting and other countries are in transition towards more forward looking monetary policies, the African countries that still maintain monetary aggregate targeting may be the most affected by any misspecification of the money demand. This is especially true since monetary aggregate targeting largely depends on a well specified stable demand for money to efficiently achieve the necessary monetary targets.

With a particular type of innovation, mobile money, it is still relevant to understand this relationship between money demand and financial innovation. Evidence of a stable money demand with the inclusion of mobile money has important implications for the effectiveness of monetary policy in Kenya, and possibly other countries that have seen developments in mobile money in recent years. Failure to account for mobile money in the money demand specification can hinder the proper monitoring of prices by the monetary authorities. This is particularly relevant for Kenya which targets monetary aggregates with net domestic assets (NDA) as the CBK's operational parameters and also monitors M3 (CBK Monetary Policy Statement, 2014b). With the growing trend in mobile money usage and with further modifications in this technology, it may become challenging in the future for the Central Bank to carry out monetary aggregate targeting. Kenya seems to be taking the right steps to improve its monetary policy. In 2011, it started the process of transitioning to a more forward looking monetary policy in order to gradually move towards inflation targeting (IMF, 2015). Other countries that have adopted mobile money technology could also learn from the Kenyan case study especially those that are still targeting monetary aggregates. Mobile money technology is evolving quickly and it may become harder for these countries to also meet their targets. Although mobile money technology could complicate monetary policy, it is expected to improve efficiency in the banking sector and the real economy through the reduction in transaction costs and improve people's livelihoods.

The fourth chapter shifts the focus away from money demand to the effect of mobile money on household consumption patterns. This chapter, just like chapters two and three, makes an important contribution to the financial innovation literature, which could have policy implications for households and the economy. The fact that mobile money users were found to spend less on necessity goods, such as food, and more on luxury goods such as housing, and transport items, suggests that mobile money not only enables individuals to receive more remittances, but also enables them to spend more efficiently on particular commodities than non-users. This could potentially improve the livelihoods of mobile money users.

There are limitations to the research undertaken in the three main chapters of this thesis. Starting with chapter two, the differences in the types of financial innovations across African countries suggest that using general proxies such as M2/M1 to measure financial innovation may not be adequate, as this proxy fails to capture the country specific innovations such as mobile money.

This suggest that, rather than relying on the broader measures of financial innovation for all the Sub-Saharan African countries, further work may need to be done using country case studies to investigate the effect of a specific type of financial innovation on money demand. Although not all the 34 countries had readily available quarterly data to carry out this study using time series analysis, as data becomes available, it would be interesting to use country specific financial innovations for all these countries as was done for Kenya in chapter three.

In chapter four, the FITS data set used was based only on one year, 2012. The study would have been richer and more informative if all of the three FITS waves were available at the time of the research. Nevertheless, for further research, and as data becomes available, it would be interesting to see the effect of mobile money on household consumption patterns over time. A panel data study could also help depict the effect of these innovations on economic development, especially in the East African region which has the highest concentration of mobile money users in the world.

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